Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

DECEMBER 1952

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Ermine Weasel

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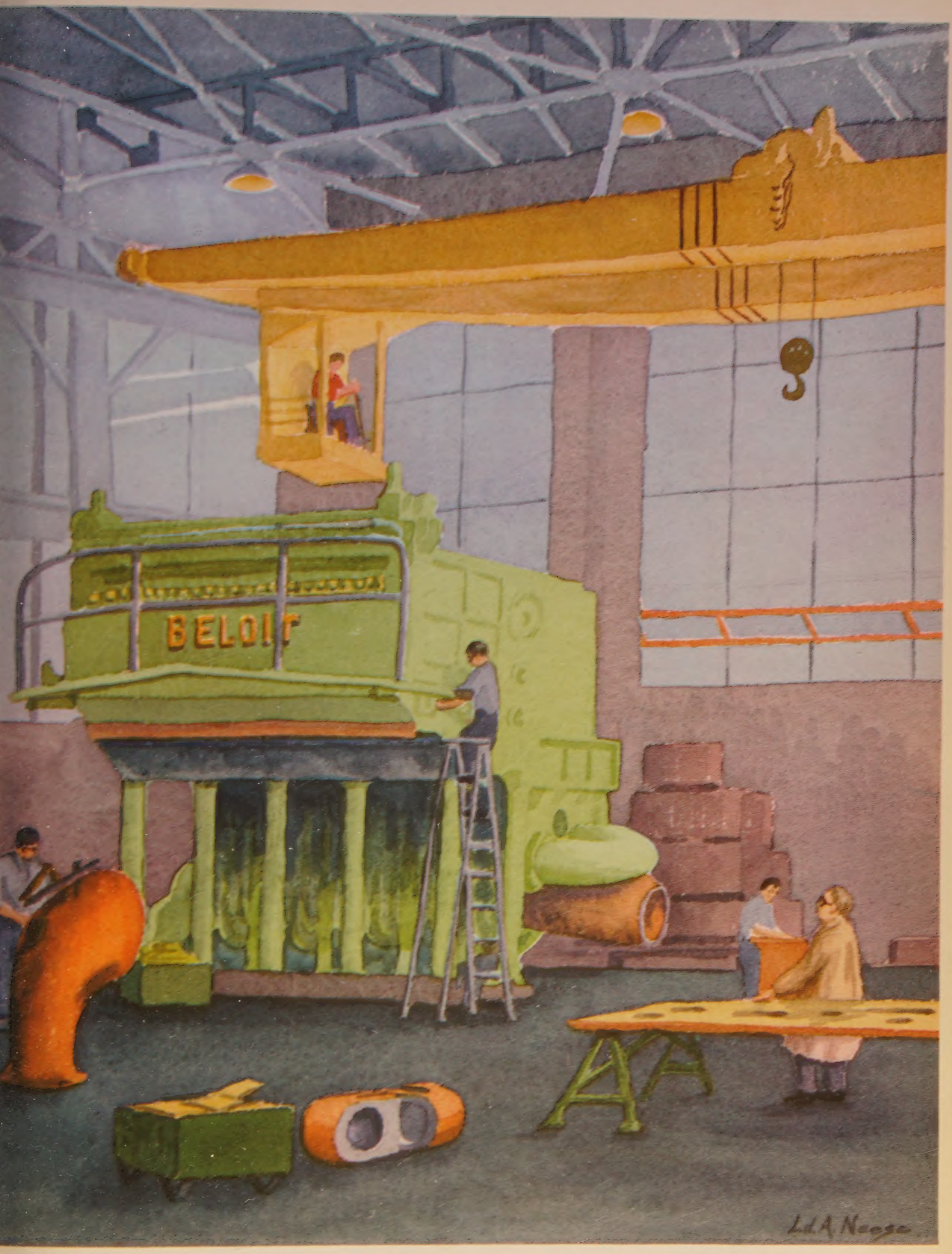

WATER COLOR PAINTING BY L. J. A. NEESE

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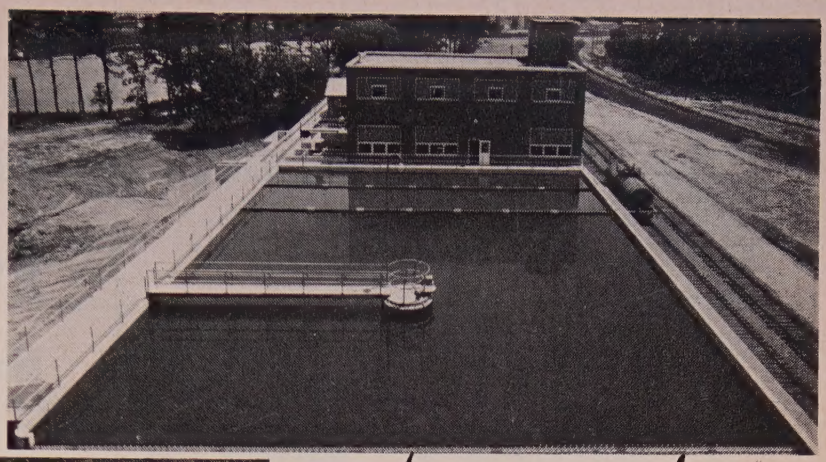
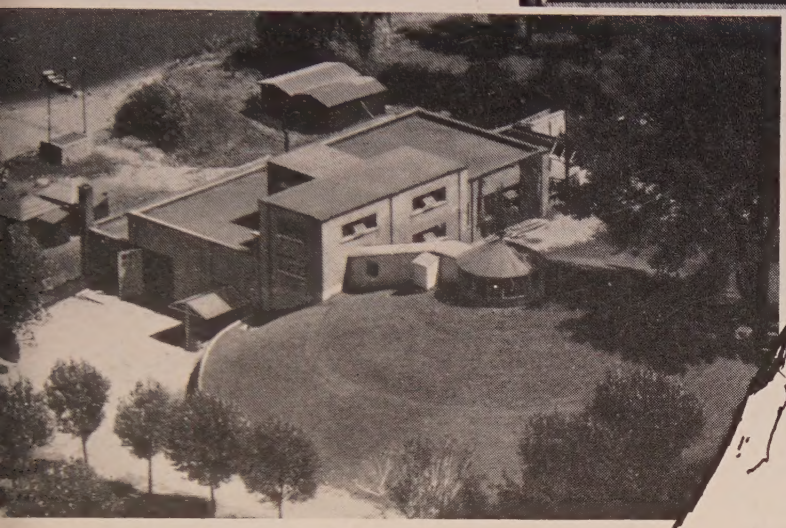


Conventional treatment at Hollingsworth & Whitney Company's Chickasaw Mills, Mobile, Alabama. Here, adequate space and a warm climate permitted this Company to take advantage of the low chemical consumption and minimum operating requirements of the Flocculator-Squarex Clarifier combination.



High-rate treatment at Canadian Celanese Ltd. in Drummondville, Quebec. This Hydro-Treator had to be covered because of the Canadian climate, it had to blend in with the surrounding residential community, and space requirements were limited.

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4. pH	8. Opacity	12. Moisture
		13. Suspension

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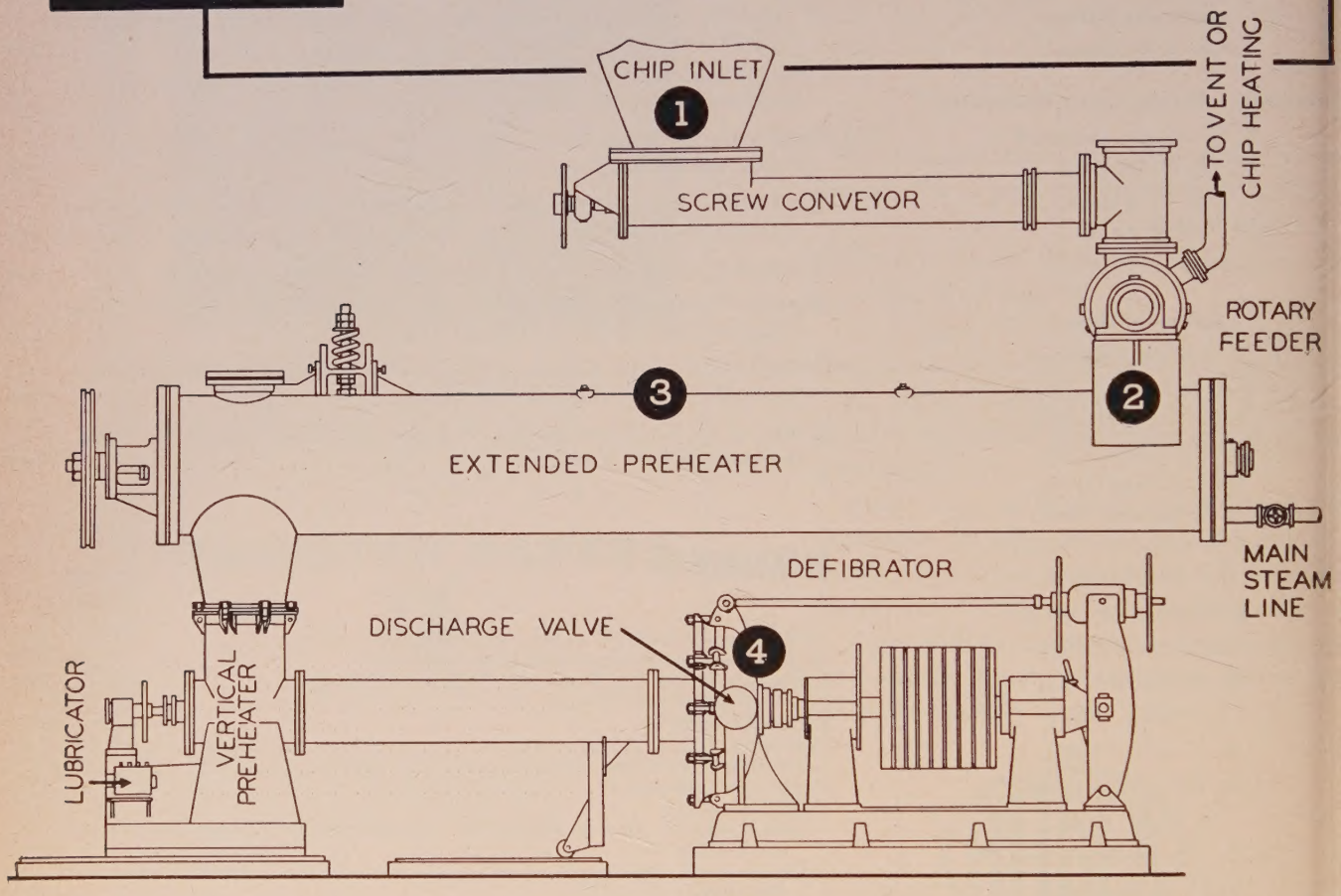

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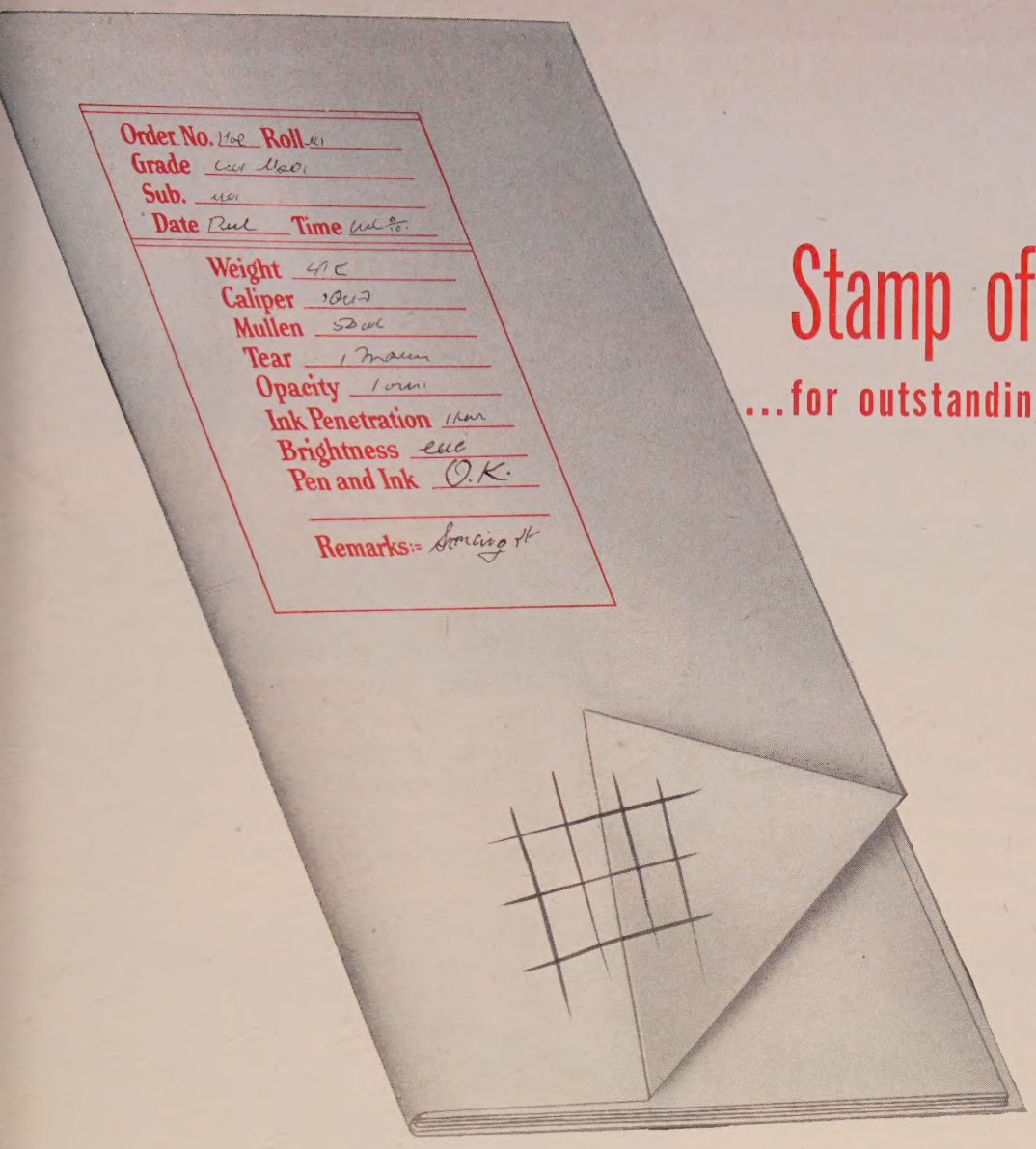

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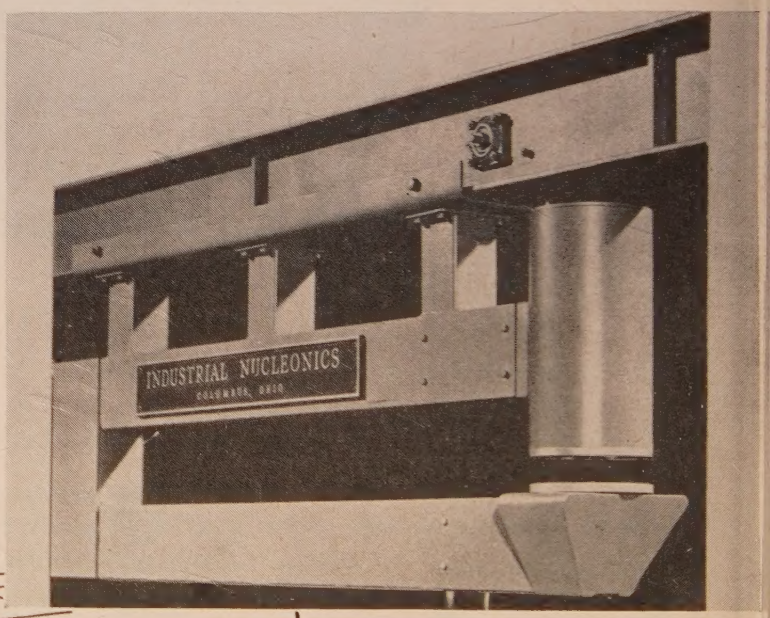

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Cellophane

GORDON C. INSKEEP and PRESCOTT VAN HORN

One of the outstanding triumphs of cellulose chemistry has been the development of cellophane. It was in 1892 that the English chemists Cross, Bevan, and Beadle discovered that a soluble cellulose could be obtained by caustic soda and carbon disulphide treatment. Development in England and France reached such a point that in 1923 E. I. du Pont de Nemours & Co., Inc., became interested, acquired American rights, and decided to build its first cellophane plant at Buffalo, N. Y. Since that time the Du Pont Co. has built three additional plants, the latest and most modern being located at Clinton, Ia.

In 1898, Stearn was granted a British patent for the production of threads, sheets, films, etc., from viscose (*24*). Six years later, M. J. R. Tiellard developed his process for the preparation of a glass substitute characterized by applying a thin layer of viscose solution on a base in order to coagulate it and dry it. However, credit for the pioneering design, and construction of machines to make cellophane in the endless sheet form of the modern product goes to the Swiss chemist, Brandenberger.

While employed by the French textile firm of Blanchisserie et Teinturerie de Thaon-les-Vosges, Brandenberger conceived the idea of making a tablecloth with a smooth finish which could be cleaned easily. He sprayed cloth with a viscose solution and then immersed it in an acid bath (*1, 4*). He achieved a smooth finish and delightful gloss, but the cloth was now stiff and brittle. In a later attempt he made a thin sheet of viscose film and applied it to the cloth.

The tablecloth project was not an outstanding success, but Brandenberger saw tremendous possibilities in the viscose film. By 1911 he had designed a machine which would produce a film of good strength and complete transparency in continuous lengths (*2, 3*). For his transparent film, Brandenberger coined the word "cellophane" from the first syllable of cellulose, plus the final syllable of the French word *diaphane*, meaning transparent.

Shortly after, the first cellophane plant was built in France by La Cellophane Société Anonyme with the financial backing of Comptoir des Textiles Artificiels. It was from La Cellophane that the Du Pont Co. secured the American rights to the Brandenberger process in 1923. The first sheet of Du Pont cellophane came off the casting machine in Buffalo in the spring of 1924. At a selling price of $2.65 a pound, it was a luxury packaging material, and only costly perfumes and candies were wrapped in cellophane.

One of the early limitations of the product was discovered when it was introduced into the field of food wrapping where it was found that baked goods wrapped in cellophane dried out too quickly. There was a definite need for a moistureproof sheet. Such a product was developed by 1927 by Charch and Prindle, Du Pont chemists (*7*). This improved film opened up thousands of new uses bringing cellophane-wrapped products into almost every home.

In addition to the original Buffalo installation, Du Pont's other cellophane plants are at Old Hickory, Tenn., Richmond, Va., and Clinton, Iowa. In 1930, the Sylvania Industrial Corp. put into operation a four casting machine cellophane plant at Fredericksburg, Va. In 1946, the American Viscose Corp. absorbed the organization, and it now operates as the Sylvania Division of American Viscose. Present installed capacity is reported to be approaching 100,000,000 lb. per yr. Last year Olin Industries, Inc., began production of cellophane in a new plant at Pisgah Forest, N. C. The Olin plant was constructed, under a license agreement with Du Pont, with an announced capacity of about 33,000,000 lb. of cellophane annually.

PROPERTIES OF CELLOPHANE

Starting from the uncoated transparent sheet produced in 1924, Du Pont has developed a total of about 130 different varieties of cellophane. Differences arise from several properties—for example, Table I shows data on the principal gages of moistureproof cellophane.

Table I. Approximate Weight and Yield of Principal Gages of Moistureproof Cellophane

Gage	*Approximate thickness, in.*	*Unit weight, g./sq. m.*	*Yield, sq. in./lb.*
300	0.0010	36.0	19,500
450	0.0014	50.2	14,000
600	0.0017	60.6	11,600

Some varieties are produced in from two to ten colors. Then there are the distinctions between uncoated nonmoistureproof and coated moistureproof; these cover several controlled levels of moisture vapor permeability and waterproofness. Both nonheat sealing and heat sealing types are now supplied for appropriate applications.

Some of the more important types of cellophane and their characteristics and recommended uses are shown in Table II.

The different types of cellophane represent various combinations of the principal ingredients. Generally the higher the softener and moisture in the base sheet the higher the initial durability. Various coating compositions and amounts of coatings make minor variations in percentage compositions. Table III gives ranges usual in domestic cellophane.

For minor special uses film is provided containing zero softener; for flame resistant decorative purposes

Gordon C. Inskeep, Associate Editor, *Industrial and Engineering Chemistry*, in collaboration with Prescott Van Horn, Film Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

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Table II. Types of Cellophane

Partial List

Du Pont designation	*Characteristics*	*Principal uses*
	Plain or Nonmoistureproof Films	
300 PT	Nonmoistureproof, air, dust, grease and oil-proof; readily absorbs water; impermeable to dry gases; permeable to moist gases in proportion to solubility of gases in water	General wrapping purposes wherein moisture protection is not needed; packaging nonedible oils and greases
300 PC	Nonmoistureproof colored film: amber, tango, red, pink, orchid, light green, dark green, dark blue, light blue	General wrapping purposes; ribbons, cord
300 PJT	Flame-resisting nonmoistureproof film; carries official Fire Underwriters' rating no. MH-2977	Decorative materials; flame-resisting windings on wire and electrical cables
	Intermediate Moisture Protection Films	
300 LST	Partially moisture protective; heat-sealing; durability equivalent to 300 MST-52	Packaging products that require controlled rate of moisture loss—i.e., slow enough to prevent excessive drying, yet able to avoid sogginess; sugared doughnuts
300 LAT	Offers somewhat greater moisture protection than LST; water-resisting for use on wet or moist products; not heat-sealing	Special containers for cottage cheese, salads, etc.; cut flowers; milk bottle hoods; certain fresh vegetables
300-450 LSAT	Partially moisture protective; about equivalent to LST; water-resisting for use on wet or moist products; heat-sealing	Luncheon meats; certain fresh fruits and vegetables
	Moistureproof Nonheat-Sealing Films	
300 MT 31	Low rate of moisture-vapor transmission; sealed with lacquer-type adhesives or with nitrocellulose solvents plus low heat; very weak heat-seals; grease and oil-proof; impermeable to dry gases or gases of low water solubility; very low permeability to water-soluble gases	Wrapping cigarettes; carton overwraps; cigar tubes
300 MT 32	Modified MT film to obtain moderate heat-sealing properties; otherwise same as MT-31	Direct wraps on cigars
300 MT 36	Standard moistureproof film, nonheat sealing; special surface characteristics	Direct wrap on caramels, nougats, kisses, etc.
	Moistureproof Heat-Sealing Films	
300 MST 51	Standard moistureproofness; good flexibility and durability	Wrapping bread; twist wraps on small objects
300-450 MST 53	Standard moistureproofness; high flexibility and durability, particularly at low temperatures and low humidities	Bags for packaging products requiring extra durability and puncture - resisting wraps particularly at low temperatures; bags for frozen foods (dry pack)
300 MSRC	Similar to PRC with addition of standard moistureproofness and heat-sealing properties; tango and black	Heat-sealed packages for products requiring protection against rancidity development
300-450 MSAT 80	Moisture protective on wet products; one side is wettable; this side, in contact with fresh meat, retards discoloration of meat surface; nonwettable side heat-seals to itself and to wettable side	Packaging retail cuts of fresh meat

clear and colored types (containing ammonium sulphamate) are produced.

When coating is applied to cellophane it usually adds 8 to 20% over the weight of the base sheet. The percentage composition of the coating is in accord with various patents cited under the description of the coating operation which follows later in this paper.

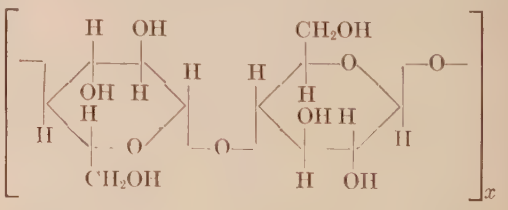
Since both cellulose and the usual softening agents are definitely hygroscopic, there is always associated with the system a somewhat variable quantity of water, dependent on the atmospheric environment. The physical and many other qualities of cellophane are wholly derived from the behavior of this three component system.

Table III. Composition of Plain (Uncoated) Cellophane

Ingredient	*Percentage range*
Cellulose	70 to 85
Softener (polyalcohols)[a]	8 to 25
Water	5 to 10

[a] Polyalcohols used generally are glycerol, ethylene glycol, propylene glycol, and to a lesser extent polyglycols and similar compounds.

The base sheet of cellophane is primarily cellulose and there are available a number of excellent standard works on cellulose chemistry, including those by Doree (*10*), Heuser (*13*), and Mark (*19*). Cellulose has been definitely established to have the empirical formula $(C_6H_{10}O_5)x$. The structural unit—$C_6H_{10}O_5$—is a glucose residue; that is, a glucose molecule from which a molecule of water has been removed. The currently accepted (*15*) formula for cellulose incorporates the pyranose ring representation:



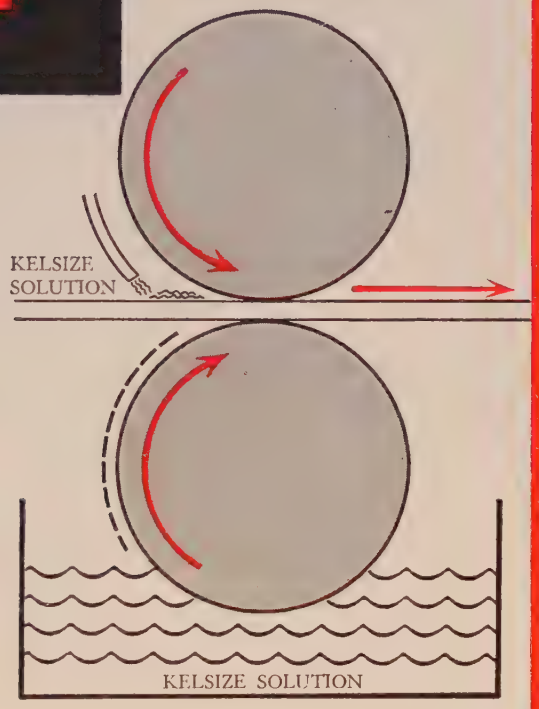
ALPHA, BETA, AND GAMMA-CELLULOSE

When a sample of purified cellulose is digested with 17.5% caustic soda for 30 min. at 18 to 22°C., that portion which remains insoluble when the mixture is diluted to 8 or 9% caustic is designated as α-cellulose. α-Cellulose is a fraction of relatively high average molecular weight and is nearly identical with pure native cotton cellulose.

From that part of the original cellulose sample which was dissolved by digestion in caustic soda, a voluminous flocculent precipitate may be obtained by acidifying the solution with acetic acid. This fraction is known as β-cellulose. That portion remaining unprecipitated by the acidification is known as γ-cellulose.

KELSIZE and KELGIN

Kelsize and Kelgin are applied as a 0.2% to 3.5% solution from calender stack or size press.



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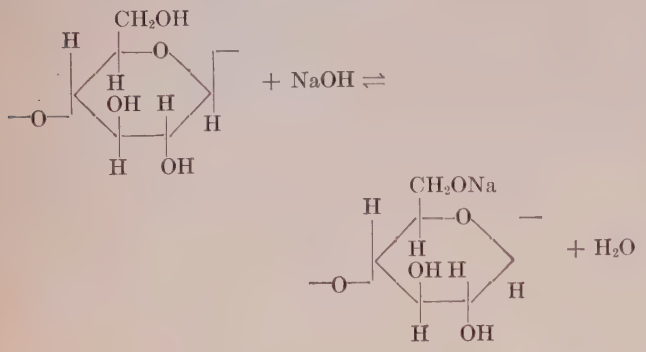
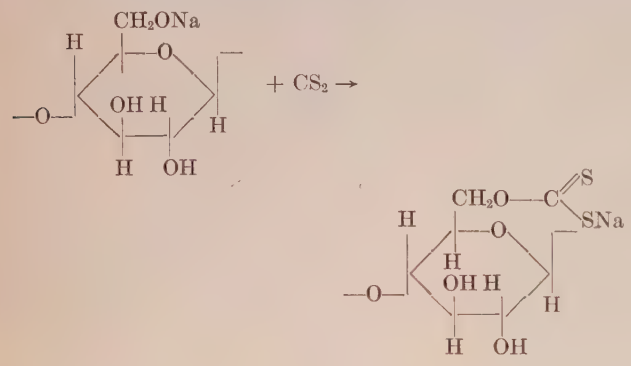
This classification is somewhat arbitrary, and it should not be inferred that α, β, and γ-cellulose are distinct chemical individuals.

In the preparation of viscose, high-quality sulphite wood pulp is steeped in sodium hydroxide solution to produce sodium or alkali cellulose. Taking one glucose unit in the cellulose chain, we may represent the reaction as follows:



The reaction is reversible so a large excess of sodium hydroxide is used to prevent hydrolysis of the alkali cellulose.

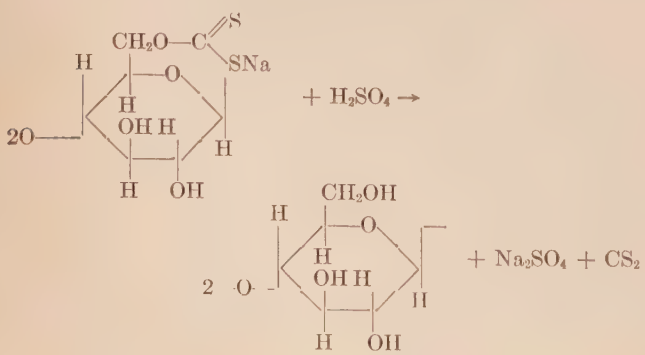
After aging, the alkali cellulose is treated with carbon disulphide and this reaction takes place:



This cellulose derivative is called cellulose xanthogenate (sodium cellulose xanthate). Chemically pure cellulose xanthogenate is colorless, but the industrial product appears yellow to orange-red because of the presence of thiocarbonates and other thio compounds present as impurities.

The freshly prepared cellulose xanthogenate is mixed with dilute sodium hydroxide to form a uniform colloidal suspension. During a "ripening" period the viscose slowly undergoes a series of reactions, including a partial hydrolysis of the xanthogenate and the formation of sodium thiocarbonate.

When the viscose film passes through the coagulation bath, after extrusion, the process of cellulose regeneration takes place. The principal reactions are:



Actually, there are two steps taking place in the bath: First, the coagulation or salting out of the viscose and neutralization of the alkali present by the sulphuric acid in the bath; and secondly the decomposition of the precipitated cellulose xanthogenate to hydrate cellulose.

After the regeneration step the treatments to which the film is subjected are mostly physical and are described in the following section.

DU PONT'S CLINTON, IOWA, PLANT MANUFACTURING PROCESS

The basic raw material for cellophane is cellulose in the form of bleached sulphite wood pulp. Other possible sources of cellulose are cotton, cotton linters, and fibers such as flax, hemp, and ramie. However, in the manufacture of cellophane, wood pulp is used exclusively because it is more stable in supply and price than other sources. Most of the pulp used is from hemlock wood, pulps from hardwoods being important alternates.

The main constituents of bleached sulphite pulps used for cellophane viscose are alpha, beta, and gamma 92 to 94% of the weight. Aside from minor resin, trace metal, and ash elements, the remaining percentage is water. There are differences, primarily in degree of polymerization as shown by viscosity, between pulp used for cellophane and that used for rayon manufacture. Analyses of typical pulps are given in Table IV.

The sulphite pulp is received at the Clinton plant in the form of sheets approximately 20 in. square and less than $^1/_8$ in. thick. The pulp is wrapped in 480-lb. bales. Each third of the bale (160 lb.) constitutes the charge for one steeping press. Most of the pulp for the Clinton plant is received from West Coast pulp mills.

Table IV. Typical Pulp Analyses[a]

Pulp use	*Rayon*	*Cellophane*
Designation (Rayonier, Inc.)	Hicolor G	Rayamo
Cuprammonium viscosity, sec.	13	4
Cellulose, %		
Alpha	93.0	89.1
Beta	2.5	6.5
Gamma	4.5	4.4
10% KOH solubility, %	8.0	15.2
Ash, %	0.06	0.06
Calcium, %	0.020	0.36
Iron, %	0.0005	0.0005
Copper, %	0.0004	0.0005
Manganese, %	0.00001	0.0001
Ether extract, %	0.10	0.23

[a] As published by Rayonier, Inc., New York, N. Y.

Caustic for the Steeping System

Caustic for the Clinton plant is received by tank cars containing hot 73% sodium hydroxide solution. The cars are unloaded from the top, air pressure being used to force caustic to the pump suction. Soft water is mixed with the caustic at the pump discharge at a rate controlled to result in an approximately 50% sodium hydroxide solution. The heat of dilution is dissipated through a shell-and-tube heat exchanger having a surface of approximately 1320 sq.ft. with caustic in the shell. The 50% solution is held in 50,000-gal. tanks provided with agitators and recirculating pumps.

Additional soft water is added to these tanks to give

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a 27% sodium hydroxide solution which is transferred to a 100,000-gal. storage tank. Further dilution to produce the desired concentration of steeping caustic solution takes place in an additional tank. Caustic for the steeping presses comes from this tank after first passing through a shell-and-tube heat exchanger which can be supplied with either steam or water, depending on surrounding conditions and the temperature desired.

In the following description of the process exact temperatures, concentrations, and cycle times are not cited because such factors are dependent on pulp and the whole integrated viscose process. Ranges, however, are indicated for some of the steps, and the selected value is controlled usually within rather narrow tolerance. Many alternative process and equipment items beyond those noted herein are cited by Leach (*16*).

Lotarev and Rumler (*17*) have discussed the optimum conditions for the preparation of viscose and the production of cellophane based on experimental evidence. In an earlier paper, Halama (*12*) discussed the manufacture of cellophane.

Steeping Press

The pulp, received on the first floor of the chemical building at Clinton, is transferred on skids by lift truck and elevator to the fifth floor where it is manually charged to the steeping presses, shown on the flow sheet, Fig. 1. The press tank is equipped with divider plates spaced about 4 in. apart into which the charge is evenly distributed.

After the pulp sheets have been charged, the tank is filled with a carefully controlled 17 to 21% caustic solution at a standard temperature usually between 18 and 25°C. The steeping time varies considerably from pulp to pulp, being set at the proper time in the range from 20 to 60 min. depending on reacting characteristics. Following the proper interval the ram is advanced, the caustic drained, and the sheets, now called alkali cellulose (A.C.), are pressed to remove excess liquid.

The steeping presses are each provided with a 63-ton, 8-in. diam., 94-in. stroke hydraulic cylinder. The press rams are equipped with a cam arrangement for automatic valve positioning. As the ram advances, it first opens a valve, allowing the caustic to return to the circulating supply tank. As the ram advances further, it closes the first valve and opens another valve, allowing the final expelled caustic to go to a segregated caustic tank for subsequent process use. Finally, a limit contact reverses the ram automatically, and it returns to its starting position.

The segregated or slurry make-up caustic contains the highest concentration of hemicellulose developed in the system. Hemicellulose is that portion of the pulp dissolved by the steeping caustic, probably being mostly gamma and some beta-cellulose. High concentrations of hemicellulose in the steeping caustic inhibit the swelling of the pulp, and later generally result in impaired reactivity and poor viscose filtration.

Pressing is carried out to the point that the weight of alkali cellulose is at some specified point in the range of 2.5 to 3.2 times the original weight of the pulp charged. The proper point is established to provide best filtering viscose later in the process.

Shredders

The alkali cellulose is removed from the steeping presses and dropped through chutes into large batch shredders located on the fourth floor. The shredders are of cast iron construction and are equipped with heavy driven blades which cut the A.C. against the saddle and macerate it to the desired form. The sigma-type blades turn at 43 r.p.m. The shredders are jacketed and supplied with brine or cooling water to control the temperature. The purpose of shredding is to ensure uniform caustic distribution and temperature, which in turn ensure uniform aging and xanthation. The oxidation and depolymerization of the cellulose proceed during shredding, and hence efficient temperature control is necessary. The shredding operation requires between 30 and 90 min. depending on equipment design and pulp characteristics. Short shredding schedules must be compensated for by increased temperatures or longer aging periods.

Aging

The shredder contents are dumped through chutes into aging cans on the floor below. The cans, of welded sheet metal, are approximately 3 by 3 by 6 ft. high and are mounted on wheels. The temperature of this entire third floor is controlled within ±1°C. The cans are sized so as to receive one full shredder charge.

Aging is carried out in order to continue the celluloses degradation to the desired point. In present practice the aging period ranges from 20 to 30 hr.

Carbon Disulphide Reaction

The aging cans are discharged through chutes into barattes located on the floor below. Three cans are used to charge one 1020-gal. baratte. The baratte is a water-jacketed, hexagonal steel drum supported horizontally in a frame on trunions at the drum ends. One of the six sides is equipped with a hydraulically operated door through which the A.C. is introduced and sodium cellulose xanthate is later removed.

The barattes rotate slowly. Carbon disulphide is admitted by gravity through a central distributor pipe and reacts with the shredded A.C. to form sodium cellulose xanthate. Carbon disulphide is added as a definite proportion by weight of the original dried pulp to yield a filterable, good quality viscose.

The normal xanthation period is usually at a point in the 75 to 150-min. range. The temperature is closely controlled during the entire cycle. The carbon disulphide and alkali cellulose reaction is exothermic laboratory measurements showing about 50 B.t.u. per lb. of dry pulp.

Slurry Tank

Alternate barattes of a pair are discharged through a chute into a slurry tank on the ground floor. Slurry make-up caustic and water are added and mixed thoroughly with the xanthate to produce a slurry of the desired composition. The vessel is brine-jacketed for temperature control. Each of the slurry tanks has a capacity of 192 cu. ft. A two-bladed sweep agitator rotates at 51 r.p.m.

Viscose composition for cellophane is established on the basis of quality, processability, and economy. Cellulose content may be in the range of 6.0 to 12.0% with sodium hydroxide ranging from 1.0 to 4.0% lower

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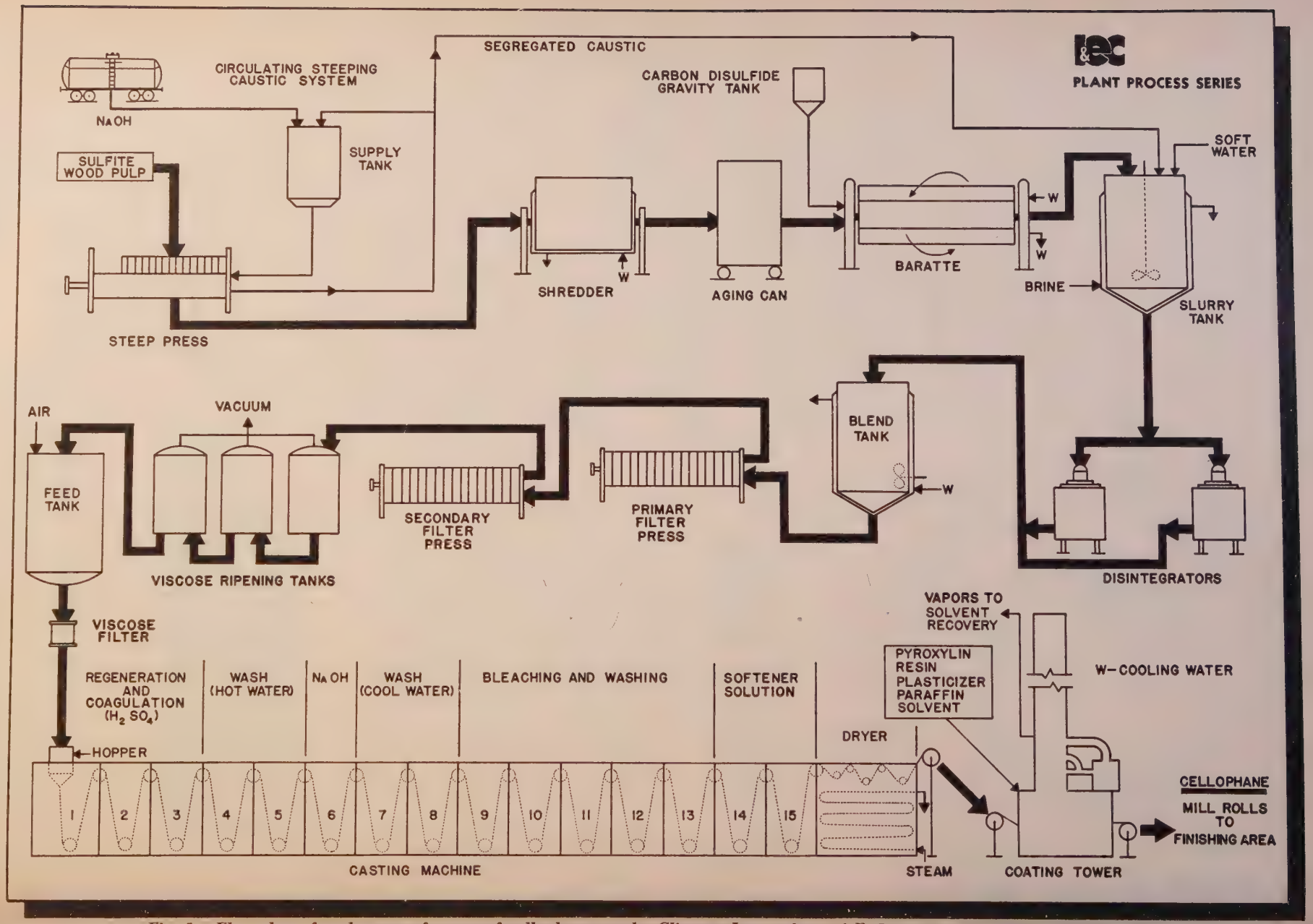

Fig. 1. Flow sheet for the manufacture of cellophane at the Clinton, Iowa, plant of E. I. du Pont de Nemours & Co., Inc.

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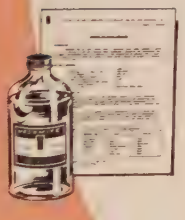

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than the cellulose. Sulphur content follows from the carbon disulphide addition to the barattes.

The slurry is pumped through one or more disintegrators. This method of viscose mixing has been described by Nash (*20*). The disintegrator is a high-speed, vertically mounted mill with hard-tipped hammers which pass close by metal screens with varying hole size. The disintegrators are driven at 3600 r.p.m. They are of cast iron and steel construction.

The disintegrator discharges to a large tank where several charges are thoroughly blended to minimize irregularities in viscosity and composition.

The blended viscose is filtered through 36-in. plate-and-frame filter presses. There are two such presses for each of the several process lines piped in parallel so that one press may be redressed while the other continues in use. The presses are dressed with cotton batting and unbleached sheeting. The sheeting is primarily a support for the cotton batting.

Although the filter frames never become filled, the resistance to flow gradually builds up as the pores of the dressing become clogged. When the discharge pressure of the gear type feed pump reaches 120 p.s.i., the flow is switched to the clean press. The filtration rate depends on the viscose characteristics acquired during the previous steps. In normal operation, before plugging, from 120,000 lb. of viscose up to ten times this figure can be filtered through one press. This higher figure is equivalent to approximately 4000 lb. of viscose per square foot of available filtration area.

The filtrate from the first-stage press goes to one of two receiving tanks, from which it is pumped through a similar second-stage press. Since there is very little plugging encountered in this second-stage filtration, only one press is required.

Viscose Ripening Step

From the press, the filtered viscose goes to a series of 3000-gal. tanks. The viscose is transferred by vacuum through a series of such ripening tanks. During this stage of the process, sodium cellulose xanthate decomposes from the initial ratio of carbon disulphide to glucose to a much lower ratio. In this period of 20 to 30 hr. in a cool temperature-controlled room, degradation products of carbon disulphide are formed such as sulphides, trithiocarbonate, sulphates, thiosulphates, and other complex sulphur compounds.

The extent of viscose ripening is followed by means of a "salt index." The salt index is established by determining the concentration of sodium chloride which is necessary to precipitate 1 drop of viscose under a given agitation at a given temperature. Trends away from normal are compensated for by adjustments to time and/or temperature in the room.

Another characteristic of the viscose which is followed closely during the ripening stage is its viscosity. This is measured by the operators, using a standard flowout tube and stop watch. Trends away from normal are compensated for by altering the time or temperature at the third floor A.C. aging step.

One important purpose of the viscose ripening stage is deaeration. This is accomplished by the transfer of viscose charges from one ripening tank to the next by vacuum and by storage under vacuum.

The deaerated, filtered, and ripened viscose finally goes to a feed tank and is placed under air pressure. The viscose flows from the feed tank through a basket strainer which contains a fine-mesh Monel screen to remove possible dirt or scale.

Casting Hopper

At this point, the viscose is a complex colloidal dispersion of cellulose, sodium cellulose xanthate, and sodium hydroxide. It carries the established cellulose content with a degree of polymerization of 575 to 600. The degree of polymerization as defined by Staudinger (*23*) is the molecular weight divided by 162. Also present are around 1.5 to 3.0% sulphur as xanthate sulphur and additional degradation compounds described under viscose ripening. The viscosity is about 50 poises.

The viscose is metered to a casting hopper through an adjustable speed viscose feed pump. The cellophane sheet is formed by the opening between the long essential edges of the casting hopper lips. The film thickness is determined by the amount of viscose extruded and the drawoff velocity. The metering gear pump is oversize by a factor of perhaps eight or ten and runs at the corresponding lower revolutions per minute to ensure the absence of leakage bubbles or cavitation.

The hopper is provided with adjustable lips which allow the viscose to flow out with the desired film thickness characteristics. These lips must be machined with a high degree of accuracy in order to extrude a film free from imperfections. The hopper lips are made of corrosion resistant alloy such as described by Petrescu (*21*).

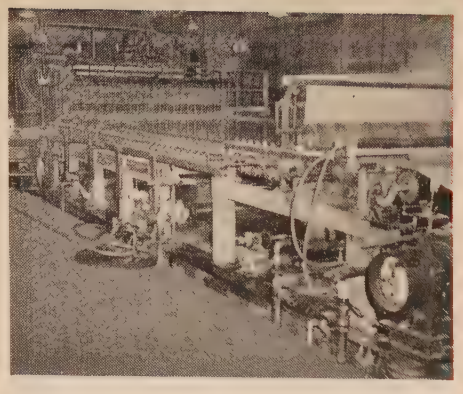
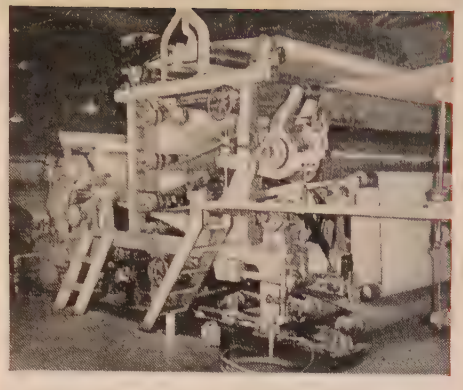
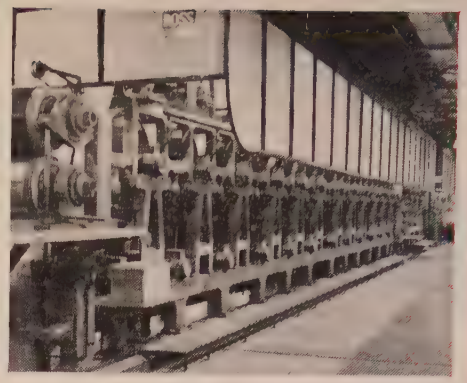
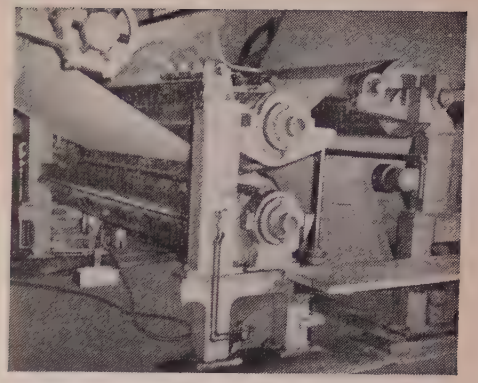
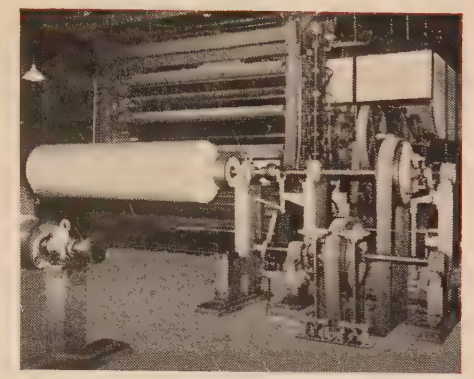
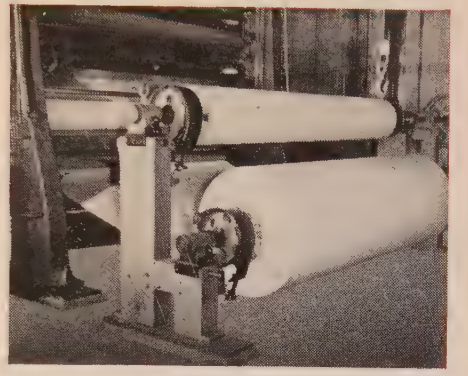
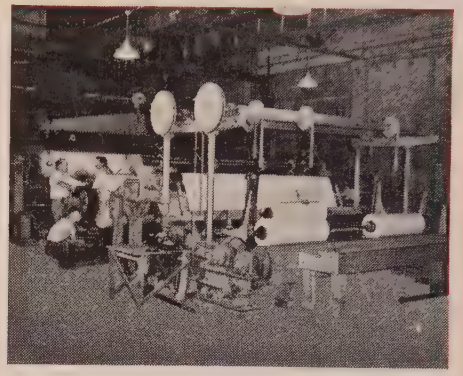
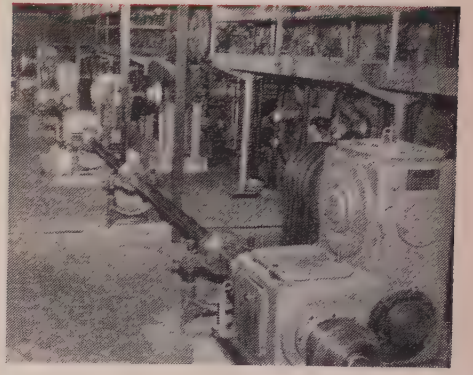
This type alloy has been found quite satisfactory for cellophane service. Hopper lips last for extended periods before regrinding. The lips are provided with adjusting bolts at approximately 6-in. or closer, intervals across their length, for orifice opening control.

The hopper is actually the head of the cellophane casting machine. The wet end consists of a series of tanks fitted with driven rolls through which the film is passed in festoon fashion. The dry end or drier consists of a series of steam or water-heated cylindrical rolls over and under which the film is threaded. The machine, including the windup section, is approximately 200 ft long and handles film approximately 50 in. wide at the windup. In the Clinton plant, 16 casting machines are operating, one beside the other.

Coagulation and Regeneration

The extruded viscose leaves the hopper and enters a bath containing sulphuric acid and sodium sulphate. The temperature is held at a point between 38 and 45°C. The bath is usually referred to as the high sulphate or "HS" bath. Its two primary functions are: (1) to coagulate the viscose into a film, and (2) to regenerate or convert cellulose xanthate to cellulose.

The HS bath is circulated around a system including the casting machines, constant head loops, evaporators and settling surge tanks. Excess water from the viscose and also the neutralization reaction is evaporated in rubber-lined single-effect evaporators. It is a closed system, fresh acid being added to keep the percentage at the required level, and the only removal from the system is the water, by evaporation, and the salt and

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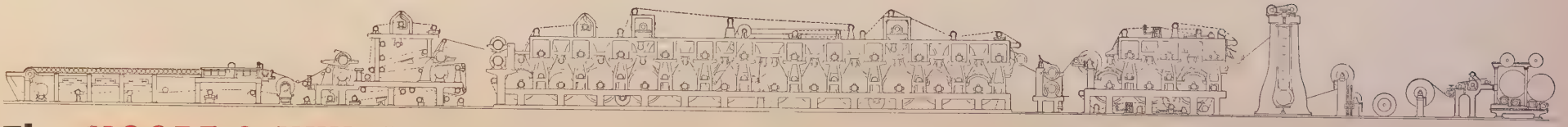

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acid solution by carry-over, on or in the film, to the next tank.

The next two tanks contain sulphuric acid and sodium sulphate of lower concentrations than those in the HS bath. The first six or seven tanks are covered with hoods piped to exhaust fans for removal of carbon disulphide and hydrogen sulphide fumes.

The fourth and fifth tanks in the casting machine contain hot water, which drives off most of the hydrogen sulphide and carbon disulphide and washes salt and acid from the cellulose sheet. The following desulphuring tank is fed with segregated steeping caustic which is converted to sulphide and polysulphides as such compounds are dissolved out of the film. Tanks 7 and 8 contain warm water for further washing.

In the next five tanks the film is bleached and again washed. The function of the bleach is to decolorize the cellulose sheet and remove practically all the remaining sulphur compounds.

The last two tanks contain the softener solution. This is usually ethylene glycol or glycerol. Gel film at this stage will carry a consistent ratio of dilute softener to cellulose. By allowing the liquid in the gel and the bath to reach a practical equilibrium and then removing the excess surface liquid, the wet gel entering the drier carries a consistent percentage of the softener. When the water is evaporated, most or all of the less volatile softener remains with the film.

Most uncoated types of film are sized to provide proper surface characteristics even under hot humid conditions of use such as prevail in the tropics and in most sections of this country in summer. This sizing is necessary for machine applications and prevents blocking and sticking during storage and handling. The size is applied as a dispersion in the softener bath with which it is compatible (*11*, *22*). It dries to a thin powdery dust on the surface of the film and is effective because of its comparative inertness to atmospheric humidity.

Water-soluble resin treatment of the base film for some types of anchored stocks is applied also in the softener tank, as described by Charch and Bateman (*5*). Such anchored coated films are designed for use with wet products. The resin is partially cured (polymerized) in the casting machine drier and finally, in coating, is further cured to enhance the adhesion of the coating to the base sheet.

The film after leaving the softening tanks passes through a drier section consisting of internally heated cylindrical rolls and a forced hot-air circulating system, with accompanying enclosures, fans, pumps, heaters, and duct work.

After leaving the drier, the film is wound into mill rolls. These rolls weigh up to 950 lb. and the largest contain almost 5 miles of film.

Control analyses cover concentration of reacting chemicals in the wet end tanks. At the windup, samples of film are tested for both physical and composition factors such as thickness uniformity, unit weight, clarity, moisture, and softener.

Special Coatings

Plain cellophane as it comes from the casting machine has undesirable properties limiting its utility essentially to ornamental and sanitary protective requirements. To achieve in addition the desired degrees of moisture-vaporproofness, heat sealability, waterproofness, and improved appearance in many combinations for specific applications workers such as Charch and Prindle (*7*), Cornwell (*8*, *9*), Hitt (*14*), and others have developed coating compositions.

A typical coating composition consists of pyroxylin, plasticizer such as dibutyl phthalate or cyclohexyl butyl phthalate, resin such as ester gum or dewaxed damar, and paraffin wax (*14*). These materials are dissolved in carefully proportioned solvents consisting of mixtures of ethyl acetate, toluene, ethyl alcohol, and possibly some higher boiling alcohol or ester in small percentage. Many other combinations of ingredients and solvents would be possible, the selection being governed by resulting film characteristics, cost of ingredients, and economics of solvent recovery.

The pyroxylin is dissolved first and the composition is determined and adjusted to ensure the desired exact percentage. The other ingredients and solvents are weighed accurately, generally on platform dial scales. On completion of mixing, the bath viscosity is checked. Bath temperature is controlled to $\pm 1°C.$ at a level to ensure an ample safety factor to keep the wax in solution. Between the mixer and an intermediate larger storage tank the bath is filtered to remove foreign particles. The bath solids are established at some suitable point between 8 and 20%, governed by limiting viscosity and sometimes by coated film properties.

From the intermediate storage tank the bath is circulated continuously through a pressure loop adjacent to the coating towers, where it is applied to the film.

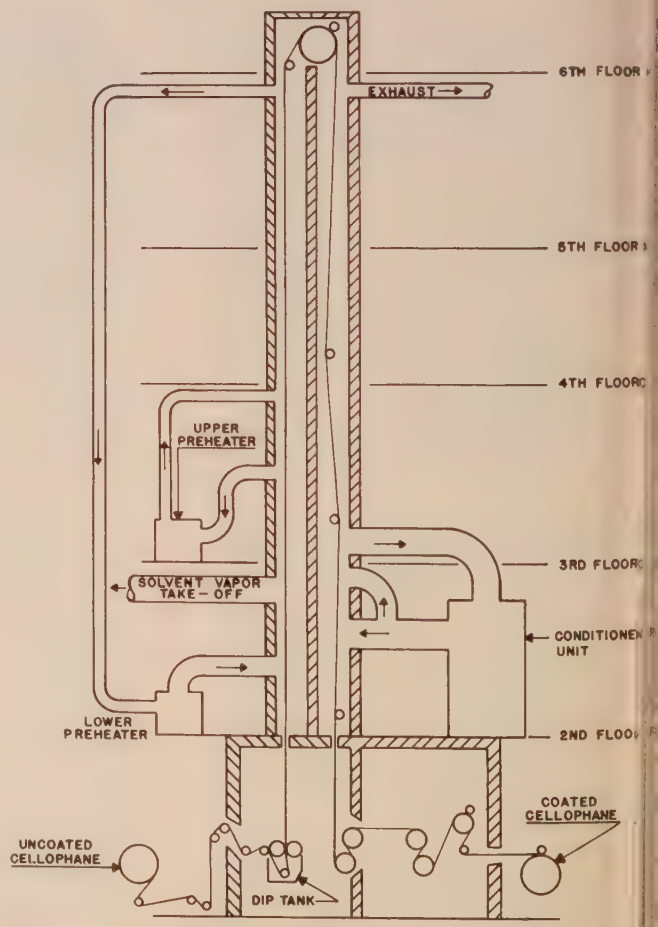
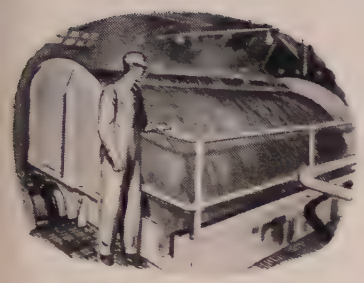


Fig. 2. Cross-sectional diagram of a typical coating tow

Kill slime,



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150th Anniversary

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Constant level automatic controls on the tower dip tanks draw bath from the loop to replace that consumed. A dip tank circulating system on each tower serves to maintain constant bath temperature and clean bath. Each tower may be serviced by two or three supply loops from as many different bath mixing and intermediate storage systems.

It is imperative to prevent contamination of one type of bath with another, so great care is exercised in segregation of systems. When production requires changing the bath type on a system or tower, the lines and dip tank are first drained to the corresponding returned bath reservoir, then flushed with solvents, and finally drained before the new bath is introduced.

One of the early coating towers is described in a patent by Charch and Craigue (*6*). It consists essentially of an unwind stand, coating bath dip tank, doctor blades, drier, rehumidifier, and windup stand. The doctor blades are one of several means, such as doctor rolls, and air doctor knives, which serve (1) to remove excess coating bath and (2) to distribute coating uniformly across and along the sheet. Figure 2 is a cross-sectional diagram of a typical coating tower.

The Clinton plant coating towers are equipped with doctor rolls as opposed to the doctor blades disclosed by Charch and Craigue (*6*). Because of the pressure of the bath in the nip, as the film passes vertically up between the horizontally mounted pair of rolls, the space between the rolls at the middle is widened. If no corrective were included in the design, the coating thickness across the cellophane sheet would be crowned. The rolls are accurately ground to compensate for this crown effect. Bath viscosities and solids content must be established and maintained uniform to obtain even coating distribution, once the crown is ground on a set of rolls.

The drying must be accomplished in such a way as to maintain always a large excess of air above the lower explosive limit of the solvent-air mixture involved. Also, the wax in the coating must be precipitated in a controlled manner without producing excessive blush or haze. Sufficient exposure time is provided to permit exhausting all traces of solvent from the coating to produce odor-free film. The solvent-air mixture is withdrawn to the solvent recovery area.

In accomplishing the drying step much moisture is removed from the film, and this must be replaced. In the rehumidifier side of the tower, by proper selection of temperature and relative humidity of the circulating air, the moisture is replaced in the film. Controlled external high humidity conditioners maintain constant circulating air conditions and with proper distributing ducts inside the tower the moisture regain is uniform across the width and length of the sheet.

Following the conditioner the film is cooled and rewound. Recording controllers maintain constant conditions throughout the coating process. Film samples are taken at roll breaks and tested periodically. Tests are run on such quality features as coating distribution, coating thickness, moisture vapor permeability, moisture content, heat seal, blush, streaks, and surface slip.

Recovery of Coating Bath Solvents

The coating solvent recovery system as outlined in the flow sheet, Fig. 3, is designed to adsorb the solvents in vessels containing activated carbon. The solvents entering the adsorbers are mixed with air to maintain a ratio 55 to 65% of the lower explosive limit.

A large diameter duct system collects the solvent-laden air from the towers and delivers it through branch lines to the individual adsorbers. In the main duct system are (1) a filter to catch loose cellophane particles, (2) a fan to move the air, and (3) coolers to regulate the temperature.

Of the three copper-lined adsorbers, 8 ft. in diameter and 23 ft. long, each contains approximately 6 tons of carbon pellets supported on a perforated pan above the adsorber floor. Each adsorber is equipped with a 6-in. vapor take-off duct for the stripped solvent.

Throughout the entire Clinton plant modern instrumentation is in evidence, but it is in the solvent recovery area that the most striking results can be observed. The entire operation, housed in a three-story building and consisting of adsorbers, batch and continu-

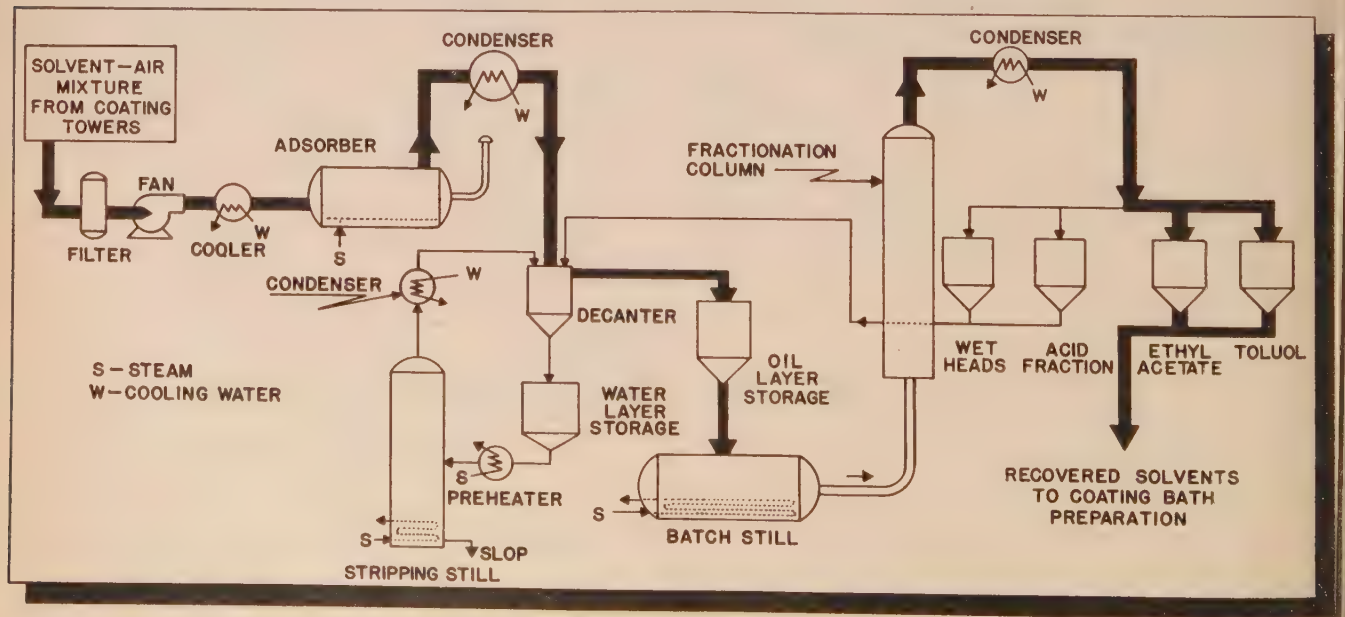
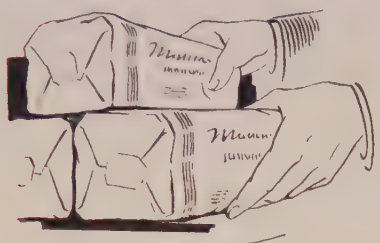


Fig. 3. Flow sheet for the recovery of coating solvents

Butchers...

Bakers...



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- ☐ Fruit and vegetable coating
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WAXES · LUBRICANTS
PROCESS PRODUCTS

ous distillation units, decanters, and storage operations, is handled by one man per shift.

From a central panel board the principal operations of all these units are recorded and controlled. In the adsorption system a cam-actuated cycle timer operates all the remote valves as determined by a preset over-all cycle timer. The adsorbers are alternately put on line to receive the solvent air mixture, steamed to strip the solvent for subsequent recovery in the distillation system, cooled, and returned to the adsorption step. The cycle once set will continue to repeat until interrupted. The over-all cycle timer can be adjusted to compensate for different rates of solvent flow coming from the coating area.

Also in the solvent recovery area are two 30-plate, bubble-cap columns approximately 2 ft. in diameter and two batch stills equipped with 20-plate columns. The distillation systems are extensively instrumented.

Winding or Sheeting

The uncoated and coated cellophane wound on the large mill rolls is moved by overhead monorail to a lag room. It remains here until final analyses have been reported and shipping instructions received.

From the lag room the cellophane may go to a slitting machine which cuts the web in the desired widths and rewinds it for shipment. The slitting machine is a high-speed tool with adjustable knives capable of dividing the ordinary 50-in. mill roll into a number of smaller width rolls. Approximately 90 to 95% of the United States cellophane production is sold in roll form for use either directly or after conversion. By far the greater proportion of this material is applied to the final packages by automatic machines.

However, there is still a sizable demand for cellophane sheets. Cellophane for this purpose is wound from the mill roll onto a sheeting drum approximately 9 ft. in diameter. The cellophane is cut from the drum and drawn along a long table feeding a knife cutter. Smaller sheets are cut, using modern single-shear cutting action machines 64 in. in width and powered by a 1.5-hp. motor.

CHEMICAL AND PHYSICAL CONTROL

Throughout the cellophane process extensive chemical control is applied to ensure standard purity of ingredients and proper composition of process materials. Many of the tests are run on a 24-hr. basis in order that adjustments in process variables can be made with a minimum of delay. Table V shows a few of the analyses conducted on a routine basis.

Table V. Chemical Control Analyses
Partial List

Material	*Determine*
Essential materials	Items covered by purchase specifications
Steeping caustic	% NaOH; % hemicellulose; % chlorides (to detect refrigerating brine leaks)
Viscose	Viscosity; salt index; % NaOH; % cellulose
HS (coagulating) bath	% H_2SO_4; % Na_2SO_4; temp.; turbidity
Tank 6 (desulphuring)	% Alkalinity
Softener baths	Sp. gr.; temp.; pH; bacteria count
Cellophane as cast	% Moisture; % softener; pH
Coating bath	Viscosity; % solids
Adsorber tail stack	% Ethyl acetate

A large number of cellophane properties are determined by physical or visual tests. Typical examples of these are shown in Table VI.

Table VI. Physical Control or Characterization Tests
Partial List

Test	*Property measured*
Gage	Thickness uniformity across sheet
Unit weight	Grams per square meter
Moisture vapor permeability	Moisture vapor transmitted, g./100 sq. m./hr.
Slip	Ability of film to slip upon itself
Appearance	Streaks, clarity
Coating thickness	Grams coating per square meter
Heat seal	Strength of seal on heat sealing types
Scott test	Elongation and tenacity
Tear test	Grams to cause cut film to continue tearing
Tumbling test	Number of drops to cause bags of rice to break

Statistical quality control has been emphasized throughout the Clinton plant. One staff engineer devotes full time to coordinating this endeavor. The company believes that each employee must understand the basic principles of quality control and the importance of high-quality production. Each operating employee is given a training course in quality control fundamentals. The operators in the plant plot their own control charts and the limits are re-evaluated periodically.

Quality control has disclosed lack of adequate uniformity in certain essential materials. As a result of these findings, some suppliers now use quality control in their plants with a subsequent improvement in the cellophane operation.

POWERHOUSE

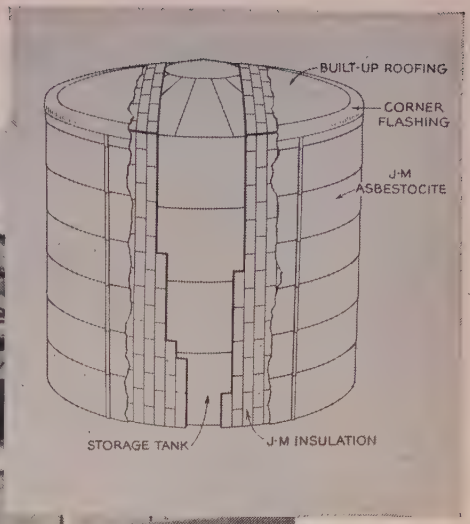
Steam, electricity, raw and soft water, brine, and air are the utilities provided by the powerhouse.

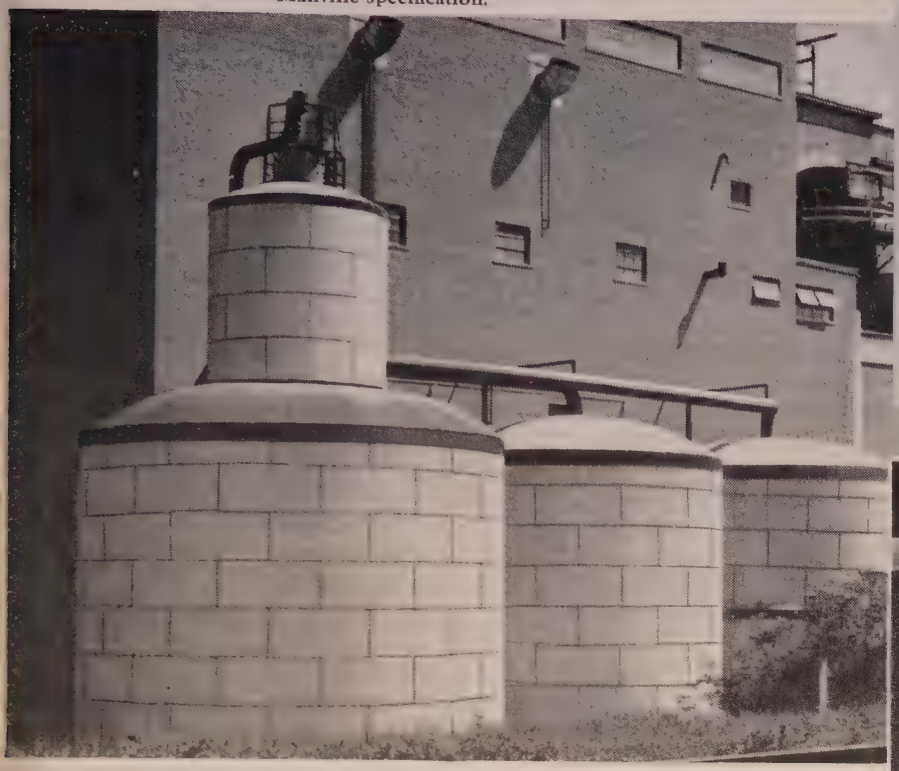
Steam is generated in two powdered coal or oil-fired boilers rated at 90,000 lb. per hr. each. Boilers operate at 550 p.s.i. and 700°F. Bleeder turbines provide electric power and some 150-lb. process steam as well as exhausting into the 20-lb. low pressure steam mains, for distribution throughout the plant. High efficiency is maintained by capacity operation at all times. Supplementary and peak load steam is purchased from a nearby public utilities power plant. Electricity in excess of that generated in the powerhouse is purchased also.

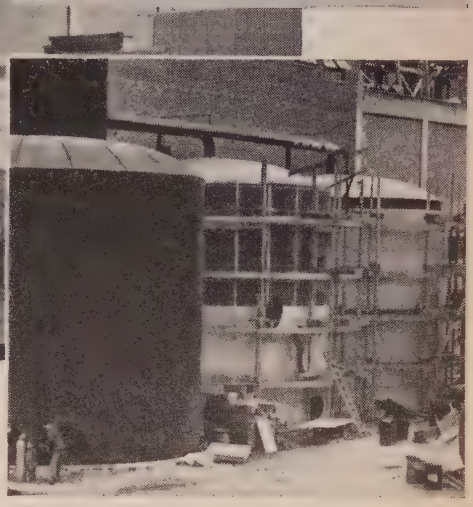
Raw water is obtained from five deep wells taking their supply from strata 1500 to 2200 ft. below the surface. The water is clear and cool and can be used with Calgon treatment directly in coolers and condensers. Its temperature remains practically constant at 63 to 67°F. the year round; consequently, condenser and cooler design is simplified. Zeolite softeners provide the necessary boiler feed and process water. The latter is used for caustic dilution, viscose make-up, and casting wash water. Chlorinated well water is used for drinking and sanitary purposes.

Brine for cooling process materials and air-conditioning is provided by large units in the powerhouse and is supplemented by self-contained conditioning units in various areas of the plant.

Cutaway drawing shows how J-M *Weather-Protected* Insulation is applied to tanks such as those at the S. D. Warren Company paper mill. Standard methods for mechanical securement of the insulation are used. Asbestocite sheets are then applied over the insulation, in accordance with the simplified Johns-Manville specification. ▶







▲ **(Above)** Completed job of J-M *Weather-Protected* Insulation on black liquor tanks of the S. D. Warren Company.

(Right) Skilled applicators of an outstanding J-M Insulation ▶ Contractor, P. S. Thorsen Co. of South Boston, Mass., applying Asbestocite sheets over Zerolite insulation.

S. D. Warren Company saves fuel, reduces maintenance on outdoor tanks with J-M *Weather-Protected* Insulation

On black liquor tanks of the S. D. Warren Company paper mill at Cumberland Mills, Maine, Johns-Manville *Weather-Protected* Insulation pays a "double dividend":

It saves money on fuel and maintenance. J-M Zerolite* insulation in 1½" thick sheets keeps the heat in . . . thereby saving a substantial amount in fuel costs. J-M Asbestocite*, a strong asbestos-cement sheet material, covers the Zerolite to protect it both from the weather and from wetting due to normal plant operations. This "bodyguard" layer of Asbestocite makes the tanks virtually maintenance-free and helps hold down operating costs.

It helps provide close temperature control. The temperature of black liquor in these tanks must be maintained so that it will flow freely and not clog up pumping apparatus. J-M Weather-Protected Insulation helps do the job dependably and economically.

Whatever the operating temperature of outdoor tanks and vessels, Johns-Manville offers the right insulation for application under the Asbestocite weather protection. For example, J-M 85% Magnesia Insulation is also widely used for this service because of its proved performance for temperatures to 600 F.

To be sure that the insulation and its weather protection is properly applied to pay the greatest return on your investment, J-M offers the services of experienced J-M Insulation Engineers and J-M Insulation Contractors. These men stand ready to give you an insulation job that will more than pay off your initial investment through maximum fuel savings.

For further information about J-M Weather-Protected Insulation, write to Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *Reg. U. S. Pat. Off.

Johns-Manville FIRST IN INSULATION

MATERIALS • ENGINEERING • APPLICATION

Compressed air, principally for viscose feed tanks and miscellaneous process and tool driving uses, is supplied by compressors in the powerhouse.

A sanitary sewage system with nine septic tanks in different spots on the location provide primary treatment. The separate trade waste collecting mains lead to a large settling basin where solids and floating froth or scum are essentially eliminated from the effluent reaching the river.

SAFETY MEASURES

Safety and housekeeping have always been watchwords in operations of the Du Pont Co. The orderliness and high level of cleanliness throughout the Clinton plant are evidence of the pride taken by everyone in his job and surroundings.

The safety record of the whole Du Pont organization is exceptional; 1951 figures showed a frequency rate for lost time injuries of 0.67 per million man-hours worked. This record compared with the 1951 rates of 9.06 for all industry and 5.48 for the chemical industry. As of July, 1952, the Clinton plant had operated more than 1400 days, over 4 years, for a total of over 8,000,000 man-hours worked, without a lost-time injury.

In addition to the ordinary safety practices usual in any operating process plant, such as eye protection, machine guards, and elimination of pinch points, there are hazards peculiar to the cellophane process. By education and universal participation in the safety program, Clinton has developed techniques which have been quite successful in overcoming the ordinary and special hazards.

Carbon disulphide and hydrogen sulphide fumes must be confined and safely disposed of. Prevention of leaks and adequate hood and exhaust facilities where fumes are generated answer this problem. Carbon disulphide is stored under water and is transferred by means of water pressure. Regular samples are taken of the air in the baratte room and other areas to make sure that the carbon disulphide content is not above the low-tolerable level.

In the coating operation, explosive air-solvent mixtures are possible. This, of course, is true in the bath preparation and solvent recovery areas too. Prevention of leaks and spills are of prime importance. Adequate forced ventilation and air volume controls with accompanying limitation on the amount of bath spread on the film in coating maintain safe conditions.

Special safety controls are incorporated in the design of all the cellophane sheet cutters to eliminate the possibility of an operator getting a hand under the blade while it is operating. Two-hand controls are located under the cutting table and the wiring is such that both buttons must be pressed and held down before the knife will move in the shearing direction.

Certain areas of the plant are designated as "goggle" areas, and the eye protection rules are rigidly followed. Every visitor to the plant is supplied with his own pair of goggles which he must carry through the plant and use in the goggle areas. Operators are issued their own goggles if their duties require entry into an area requiring such eye protection.

The Clinton plant maintains a 14-member guard force which also serves as a part of the safety department. All welding and burning jobs, as well as any other questionable maintenance jobs, must be cleared by the safety department before they are started.

As with any viscose process the cellophane plants are faced with both air and stream pollution problems. The hydrogen sulphide and carbon disulphide fumes, generally diluted to 25 to 50 p.p.m. or less, are confined at their sources and conducted to tall stacks which disperse them high in the air. It is only under extremely unusual wind and weather conditions that the fumes are discernible, even in the immediate vicinity of the plants.

Stream pollution is controlled to be well within the absorbing capabilities of the receiving waters. Viscose and acid losses are held at a minimum for reasons of economy as well as for pollution abatement. Dissolved solids, mainly sodium sulphate, are allowable at present plant locations, but generally state control agencies must approve increased or new disposal proposals.

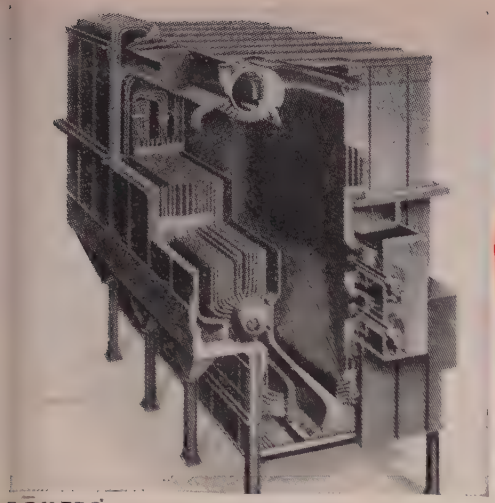
Organic constituent waste, such as hemicellulose, or solvent, creates an additional biochemical oxygen demand on the receiving stream and extreme measures are sometimes taken to reduce such contamination. When necessary, stripping stills can be applied to eliminate alcohol (orginating with the nitrocellulose or hydrolysis of ester solvents). Settling basins are utilized to reduce or eliminate suspended solids, such as sulphur sludge and cellulose, from washing and tank cleanings. Most of these measures have been applied at the Clinton plant, even though its effluent goes into the great Mississippi.

RESEARCH

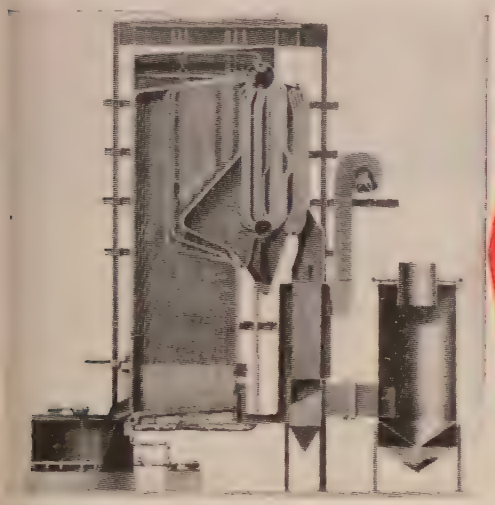
For purposes of supervision, the operation is divided into three areas, each with its own supervisors and shift foremen. These are the chemical and casting area, coating area, and finishing area, which operate 24 hr. a day. The area supervisors report to the manufacturing superintendent, who in turn is responsible to the plant manager. Other important staff officers under the plant manager include the works engineer, the accounting superintendent, the methods and standards superintendent, the technical superintendent, and the service superintendent. The laboratories and inspection personnel are under the supervision of the technical superintendent.

Of particular interest is the plant's research group. This section, consisting at the present time of 15 young chemical and mechanical engineers and chemists, also reports to the technical superintendent. Their efforts are directed along two complementary lines: (1) to maintain present operations at highest levels of quality and efficiency, and (2) to investigate longer range possibilities for improving the process and product.

The plant research section at Clinton and the similar ones at the other Du Pont cellophane plants are integrated with the department's central research organization. The plants conduct that type of research ready or nearly ready for application on full-scale equipment. A central research laboratory and staff at the Buffalo location does longer range scouting and development, and semiworks production on new products, such as Mylar polyester film. Much basic research on old and new products of the department is also prosecuted at Buffalo. In addition the film department contributes in the support of many projects of a pure or fundamental research nature at the Experimental



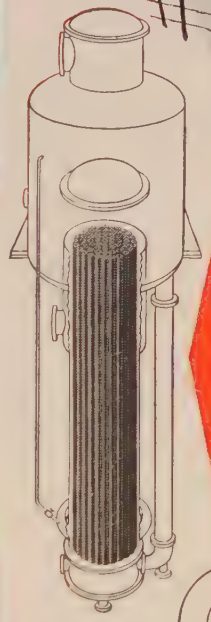
BOILERS—B&W boilers have a long and outstanding record for low-cost steam generation in pulp and paper mills. They span a range of types and sizes to satisfy every requirement of capacity, space, temperature, pressure, fuel, and method of firing. Each type combines the dependability of job-proved design with every economy of standardization commensurate with flexibility.



RECOVERY UNITS—Efficient chemical recovery and reduction, along with maximum steam generation per ton of pulp, are combined with economical operation and maintenance in B&W Recovery Units. Installations for burning waste liquors of the kraft, soda, and bisulphate (magnesium, calcium, and ammonium) processes have a total recovery capacity of over 16,000 tons. B&W recovery units were the first provided with automatic soot blowers to eliminate routine hand lancing.

PRESSURE VESSELS—Dependable welded processing units, in sizes and shapes for any paper mill requirements, are fabricated by B&W from carbon, alloy, or clad steels. All vessels are x-ray inspected and stress relieved.

time-proved aids to LOW COST production



TUBES—Seamless and Welded steel tubes are made by B&W in a range of carbon, alloy, and stainless steel analyses to satisfy every requirement for condensers, evaporators, heat exchangers, recovery units, boilers, and other paper mill applications. Modern improvements in pulp and paper processes impose a greater variety of tubing requirements than ever before. B&W Tube Representatives offer a wealth of experience on tubing problems to help users determine the analyses best suited for specific operating conditions.

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Station in Wilmington. Both personnel and ideas are continually being interchanged among these several groups.

PROCESSING FOR PACKAGING APPLICATIONS

Cellophane, like paper and other flexible wrapping materials, may reach its final application by several routes, almost every one of which involves some transformation of the continuous web into a final sealed package. The unprinted film may be sent directly to the final users who apply it directly on packages containing products ranging from pills to blankets. Other large and small direct users first form the film into bags which are then filled with their products, as can be seen in almost any retail store display. If the product package design calls for printed cellophane there are about 300 converters equipped to supply the desired material. With upward of 3000 salesmen and technical service people, these converters are ready to furnish the film best suited to do the job.

Generally, the converters start with large wide slit rolls and print several parallel designs across the web. There are perhaps eight to twelve manufacturers of printing machines, and most of the large film converters have developed machines from component parts thus available. Various types of machines will do jobs ranging from simple aniline ink to elaborate seven-color rotogravure printing. After printing, the film is slit to single design-width rolls and then either fabricated into bags or shipped as rolls for product packaging.

There are between 150 and 200 manufacturers who supply machines for handling flexible films or assemblies incorporating flexible films in combination with paper, cardboard, or other plastics. These machines range from simple hand heat-sealing irons to complicated printing–bag fabrication–bag filling combinations. Many times an application for a flexible film has had to await the perfection of an automatic wrapping machine to do the job. Cases illustrative of this are: warehouse packaging of head lettuce and mill packaging of bulky textiles such as sheets, towels, and blankets.

Cellophane does not have an exclusive field in the packaging market. Competing films include polyethylene, cellulose acetate, ethyl cellulose, saran, and Pliofilm. Also vinyls, glassine paper, waxed paper, other specialty papers, thin metal foils, and many ingenious laminated combinations compete, and quite successfully too, for position in this field. Most modern wrapping machinery is designed to handle cellophane and other flexible wrapping materials interchangeably.

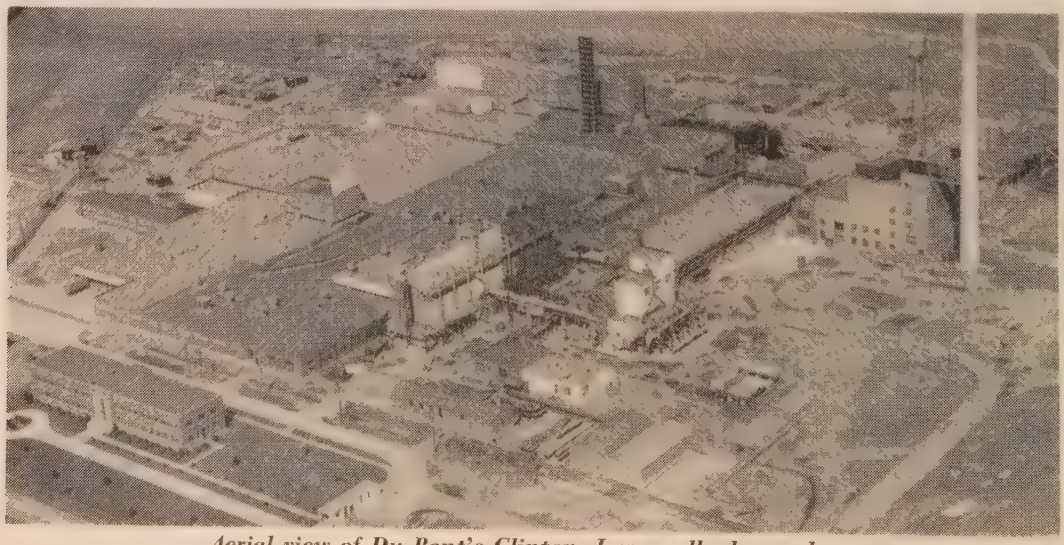
CELLOPHANE MARKETING

Cellophane should be in a favorable position to maintain and even enlarge its share of the flexible packaging and allied markets. During the postwar period large increases in cellophane capacity have been developed, thus placing the cellophane industry in a position to expand its markets. A third producer has entered the field and thus has intensified the vigorous competition to keep sales abreast of production capacity.

From the economic standpoint, the capacity increases have permitted substantial improvements in labor and material efficiencies. These have largely been passed on to consumers. Since 1941 cellophane prices have increased approximately 35%, whereas major paper-base materials entering into waxed paper and other competing wrapping papers have advanced in the magnitude of 80 to 100%. McIndoe (*18*) in a recent series of articles has summarized some of the economic factors in cellophane production. His data were presented as being applicable to a cellophane plant which might be located in western United States.

There are major fields where cellophane is now used which are still unsaturated. For various reasons the present application of cellophane covers only part of the potential. For example, it is estimated that only around 10% of the bread sold is wrapped in cellophane, less than 20% of proved applications to fresh prepackaged produce are covered, and something less than 50% of the prepackaged meat potential is now satisfied. There are broad areas in such fields as packaging candy bars, fractional unit packaging of crackers, bakery products, dried fruits, frozen foods, and scores of others where the cellophane functional advantages and selling appeal can still compete for additional business. The cigarette and cigar industries are unique exceptions in that they already are nearly saturated.

Even here, as well as in the less saturated applications, increased sales due to population growth, the supermarket trend of marketing methods, and changing buying habits, all promise a wider field for cellophane and competing flexible packaging materials.



Aerial view of Du Pont's Clinton, Iowa, cellophane plant

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It *is* important that it is the first major expansion in the country's hydrogen peroxide facilities in a long time.

Becco aims to prevent the recurrence of hydrogen peroxide shortages which have plagued the country during recent years.

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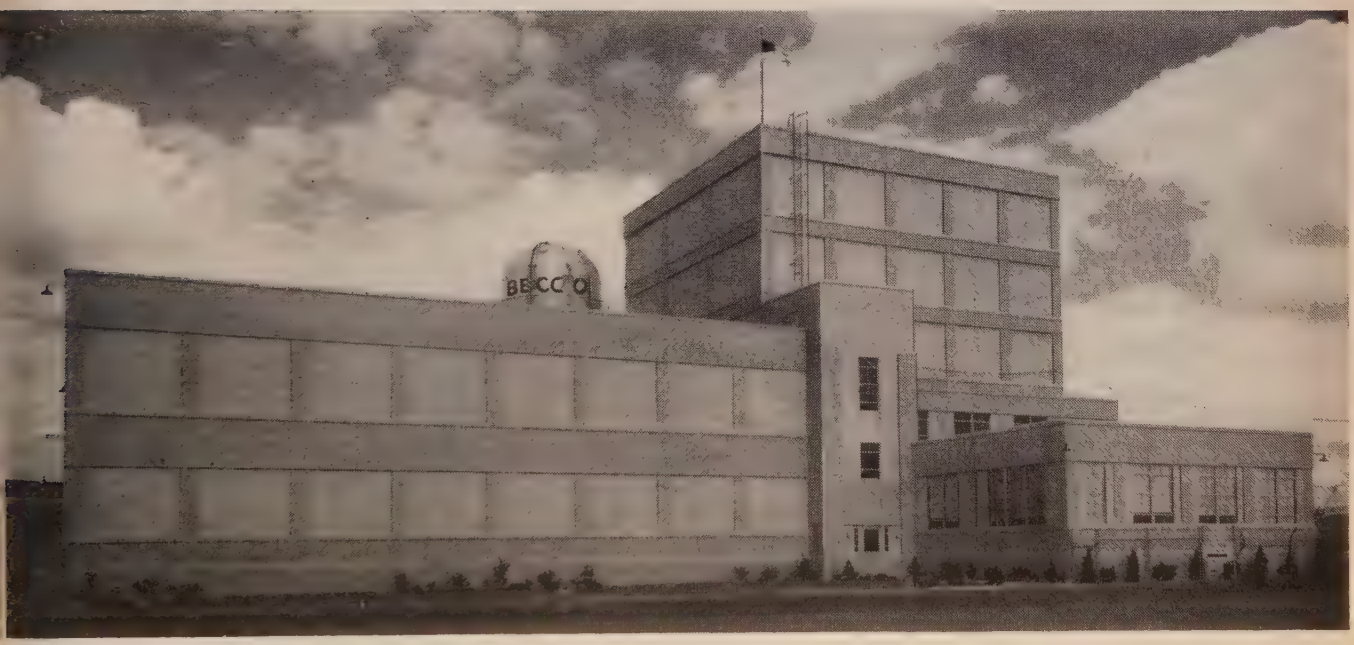

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The aggressive selling methods applied by Du Pont, the other producers, and the many converters and agents may be expected to continue expansion of the applications. These selling methods range over the whole field of product packaging and wholesale and retail marketing. Studies on buying habits, consumer preferences, package design, equipment design, packaging methods, technical servicing and assistance in equipment development, suggestions for improved display, merchandising and store planning, national consumer advertising, and many related subjects are among the services the cellophane salesmen are doing today.

The technology of cellophane production has advanced appreciably in the years since Brandenberger, but with probably at least a hundred research chemists and engineers in this country working on the development of new and improved processes and types of cellophane the three major producers are showing their confidence in the future. Just what new things will come from this extensive research effort cannot be predicted. Undoubtedly, improved quality is a major objective. Other goals are reduced investment per unit of capacity, reduced consumption of raw materials per unit of finished product, improved labor efficiency, and other such criteria of progress characteristic of the American enterprise system.

Definitely the industry believes cellophane has a promising future in the expanding market for flexible packaging materials.

The authors are indebted to the Rayonier Co., Inc., for their table showing typical wood pulp analyses. Photographs, equipment descriptions, and background information about cellophane production are credited to the operating, technical, and supervisory personnel of the Clinton, Iowa, plant.

Grateful acknowledgment is made for data and many helpful suggestions from associates in the Film Department and others in the E. I. du Pont de Nemours & Co. organization.

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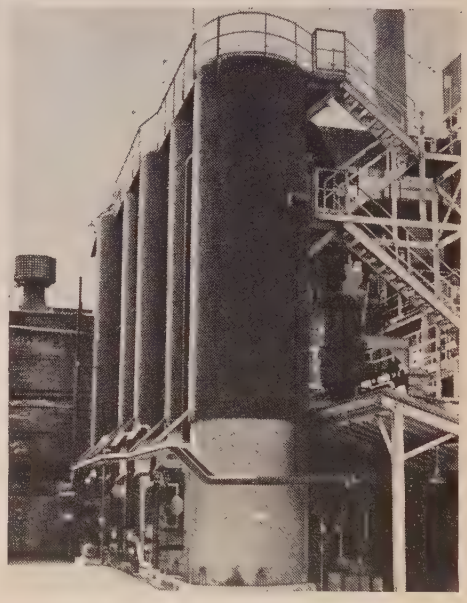

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Major Considerations in Industrial Palletization*

PALLETIZATION of packaged commodities and materials for both internal and external handling is becoming one of increasing importance with the intensification of competition and the seemingly inexorable rise in manufacturing costs. Incentives for palletization in the form of reduced overhead and expanded markets are many. The major economies thus far realized include reduced labor, damage and freight costs, expeditious handling and delivery of merchandise, and optimum utilization of both storage and transportation space. Expansion of palletization is retarded by several major obstacles which must be reckoned with by all current and prospective users of this method of materials handling. In our modern complex industrial merchandising and distribution system, problems of palletization are an inseparable part of the planning, development, and improvement of containers. A large percentage of container manufacturers are keenly aware of both the potentials and problems of the pallet industry and are working closely with pallet manufacturers and users. It is the intent of this report, therefore, to restate objectively the principal economies and obstacles as well as the growth pattern of industrial palletization, to assist and supplement the continuous study and research of this method of materials handling.

Limited pallet use by United States dates back into the pre-World War II period. The main impetus, however, came from the armed service demand during World War II. It was then that the process of palletization was determined to be the most effective method of handling materials under emergency conditions. The research, study, experience, and practical knowledge gained during this period provided the groundwork for expanded postwar commercial use of pallets.

Wood pallets, because of their extensive use by the military in World War II, best illustrate the over-all growth of pallet systems. Major types of pallets in general use are those fabricated from wood, metal, and paper or a combination of these materials. A recent development has been pallets constructed of plastic. Use of other type pallets accounts for a small part of the total number in circulation. This is attributed primarily to metal shortages during the past decade and the comparatively recent development of paper pallets. The growth of the over-all pallet industry is, therefore, briefly illustrated in the table on this page which provides data on the production and use of expendable pallets.

In 1939 only 16 manufacturers were engaged in producing wood pallets for sale. Estimates place the number at 1000 by 1950, including 700 small part-time commercial manufacturers. During 1943 and 1944 the demand from the military expanded to such an extent that it was necessary for the armed services to fabricate quantities of wood pallets in excess of the number produced throughout the entire pallet industry. The period from 1940–45 saw a total of 55 to 60 million pallets constructed, consuming over a billion board feet of lumber. This average yearly output of almost 10 million pallets was far above any prior demand from industry.

Immediate postwar industrial demand, while well above prewar years, was not heavy enough to sustain any production figures comparable to those maintained during World War II. In addition, 4 million surplus pallets released by the military from 1946–49 were added to normal distribution channels. The Department of Agriculture in its 1948 survey on "Wood Used in Manufacture" (see Table I), revealed that pallets consumed 222 million board feet in that year. The estimated amount of lumber contained in one pallet at that time was 35 board feet. Using this figure the total production of pallets in 1949 was approximately 6.4 million.

Table I. Wood Consumed in Pallet Production by Industry Group—1948

	Million bd. ft.	*Per cent of total*
Total, all industries	222.3	100
Manufactured for sale	101.3	46
Sawmills and planing mills	18.2	8
Millwork plants	12.1	6
Wooden box plants	39.7	18
Furniture and fixture plants	4.7	2
Other	26.6	12
Manufactured for own use	121.0	54
Paper and allied products	31.2	14
Steel works and rolling mills	29.2	13
Other primary metal industries	18.1	8
Fabricated metal products, except ordnance, machinery, and transportation equipment	14.2	6
Machinery, except electrical	16.8	8
Electrical machinery and supplies	6.4	3
Transportation equipment	1.9	1
Other	3.2	1

Source: Dept. of Agriculture, Div. of Forest Economics.

The Korean emergency stimulated wooden pallet production to an estimated 23 million per year. Military requirements of 1.7 million pallets were relatively light, due to a stockpile of 2 million in addition to some 60 million already in use throughout the military system. Current total production is estimated to be about the same as 1950 although military purchases for the fiscal year 1952 increased to 2,633,797. A breakdown of pallet purchases by the armed services is shown below in Table II.

In addition to armed service demand, many factors are responsible for the increased commercial use of pallets over the pre-World War II level. For instance, increased freight rates are reported as a primary motivation for the growing expendable pallet market. One such user indicated that because of this factor 98% of his entire output of hydraulic brakes was being handled with this type pallet. An official of a large motor car manufacturing firm reported that 75% of all incoming materials are received on expendable pallets.

Expendable pallets are constructed of wood or paperboard or a combination of these materials. Since many users of wooden disposable pallets fabricate their own pallets, an estimate of the quantity manufactured cannot be accurately determined. A representative of a large paperboard company estimated that although large strides have been made in the manufacture of paperboard pallets, production was still far below that of disposable wooden pallets. Use of paperboard pallets, however, has shown a remarkable growth pattern in the last 5 years. This manufacturer stated that his company started producing this type pallet in 1949 and that current production is estimated at 8000 pallets per month. Future plans call for this figure to double within a year. By the end of the developmental period, annual production of expendable paperboard pallets by this company alone is expected to reach 10 million.

The output of metal pallets has increased substantially in the past few years as new applications are increasing throughout industry. This type pallet has proved particularly effective in warehousing and production operations. Parts manufacturers and users and textile manufacturers have been using the metal pallet with collapsible sides thus making,

Table II. Military Purchase of Pallets—Fiscal Year 19[illegible] (Number)

Total	2,633,797
Navy	1,202,675
Marines	75,243
Air Force	30,459
Army	1,325,420

Source: Bureau of Supplies and Accounts, Navy Dept.

* From a special report of the National Production Authority U. S. Department of Commerce.

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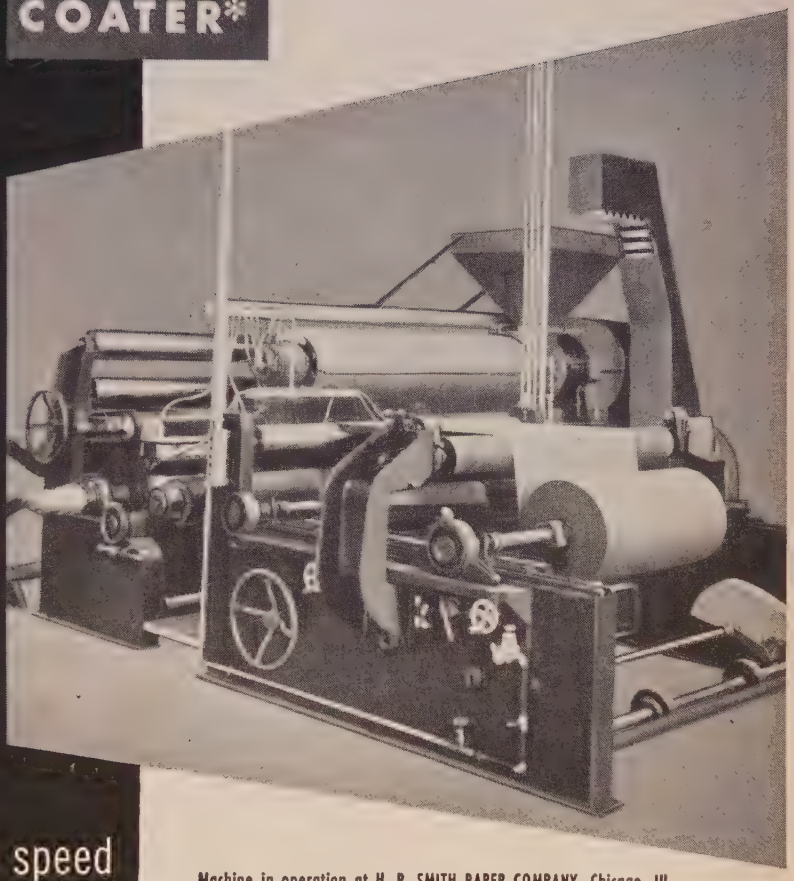

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effect, a container. In the meat and other sanitary food industries, this container-pallet has also proved to be an effective method of handling commodities. Because of the relative high cost, however, the metal pallet has thus far found limited shipping applications outside of individual firms.

In order to get the users' views on industrial palletization the Department of Commerce conducted a survey to gauge the extent of increased pallet usage throughout industry. Respondents contacted were those most likely to use pallets in their handling systems rather than an over-all sample of industry.

Results of this survey reflect some interesting developments in the utilization of commercial pallets. Eastern seaboard grocerymen, for example, reported in their industry the postwar pallet use had grown rapidly and was included in virtually all future construction plants.

Railroads in the same area reported that they were just beginning to install pallet operations. One yard estimated that established operations were presently about 25% palletized. A motor carrier firm indicated that it would not be without pallets since adopting them after World War II.

Pallet manufacturers contacted in the Midwest were quick to express their optimism about future markets. One in St. Louis revealed that his sales were up 40% over 1946 volume. Another, located in the Chicago area, expressed a similar rise and made a long-range prediction that he did not expect demand to level off for another decade.

Many wholesale grocers in the Southeast were reportedly going "whole hog" toward palletization. Textile container manufacturers and also a cotton mill reported that pallet operations had doubled since 1946. Reports from San Francisco respondents show that the postwar growth has accelerated from 10 to 35% each year.

A railroad executive in the North Central States observed that the quantity of pallets used for shipping packaged commodities has been increasing although still comparatively small. He indicated that products shipped included building brick, coils of wire and strapping, engine heads, motors, and canned foods to mention a few. It was further observed that thus far, most pallets used for shipping were constructed of wood although increasing numbers of metal and paper pallets were being used. In another instance, a large railway warehouse reported that a 10,000 pallet system has been built up since 1945. "About 10% of my total loads are being shipped on pallets," quoted an official of a trucking firm.

In the Cleveland area, a corrugated box manufacturer reported that several customers require that their orders be shipped on disposable pallets. A company manufacturing hardwood pallets for the last 16 years indicated that the last 4 or 5 years have been far the most active.

The increased use of pallets was reflected in a variety of industries in the Southern California area. Many industries indicated that future business operations were being designed to take full advantage of palletization. A battery producer who had installed a pallet system only 3 years ago on an experimental basis is now installing them wherever feasible. Sixty per cent of the total handling of a spring and bumper manufacturer is being accomplished with pallets. Several bakeries reported the same percentage of palletization in their warehouses although none were being used for shipping. A wholesale oil distributor increased his pallet system from 500 to 800 units in the last 4 years. Representatives of the bottled water industry indicated that pallet use had increased 300% since 1946 although shipping use was still limited. Several soft drink firms reported 100% utilization of pallets in warehouse operations. It was estimated that a total of 10,000 pallets were used in this area by walnut growers. Three wholesale food distributors have 50,000 pallets among them. The entire food industry in the Los Angeles region was reported pallet conscious. Plans for increasing pallet units from 900 to 2,500–3,000 by the first of 1953 were revealed by a cosmetics firm. Increasing amounts of palletized products in incoming shipments were reported by carloading companies in this area. Drug distributors also reported that their use of pallets had increased by 20% each year since 1946. In addition, the use of pallets by a furniture dealer trebled since 1949. Other extensive West Coast users include the glass container industry, fish canners, feed and flour mills, and brewers.

Materials handling men throughout the country claim that the trend toward smaller container sizes had a marked influence on increased pallet usage. A Midwest feed manufacturer was nonreceptive when first approached on the idea of using pallets. As his sales of 50-lb. feed bags increased, he recognized tremendous advantages of handling smaller sizes on pallets and now is palletized up to maximum usage.

Respondents reply to the question "When did you start using pallets?" is shown in the following résumé for the Southern California area:

Date	*No. industries*	*No. companies*
Post World War II	11	31
1940–44	3	3
Over 15 years ago	5	3
Over 20 years ago	2	3
Over 40 years ago	1	1
Unknown	2	2
	24	43

Of the 43 companies reporting above, it was found that 35 used wood pallets, 6 used metal, and 2 fiber. Thirteen were using them at 100% maximum usage. The next fifteen indicated over 60% with the remaining 15 below 50% maximum usage.

The departments in which these companies were using pallets:

Departments	*No. companies*
Handling raw materials	14
Production	18
Handling production parts	7
Handling supplemental supplies	13
Warehousing and storage	33
Handling finished goods	28
Transportation	19

The large percentage of the total cost of many items taken up by handling provides the answer for much of the post World War II pallet growth. In many instances handling costs amount to 35% of the total cost of an item, therefore, any significant reduction in handling costs will reflect favorably in decreased overhead. In the Department of Commerce survey, it was pointed out that in practically all cases the biggest savings were made in labor and storage costs. For example, on the West Coast, the heavy duty trailer industry reported that labor savings were as high as 75%. Tire producers cut labor costs in half and increased warehouse space by one third.

In the same area, 28 companies reported savings on "in-plant" conveying whereas 11 reported saving on shipping practices. Further analysis shows economies were gained in the following operations: loading and unloading, 24 companies; labor, 35 companies; storage space, 30 companies; handling damage, 16 companies. No savings were reported in reduced container requirements.

Those in the wholesale food industry reported huge savings. A West Coast operator claimed annual savings of $100,000. In New York, a large distributor revealed that one man could load a car in 10 min. whereas normally two men required from 15 to 45 min. In St. Louis, loading and unloading costs were reduced as much as 60%.

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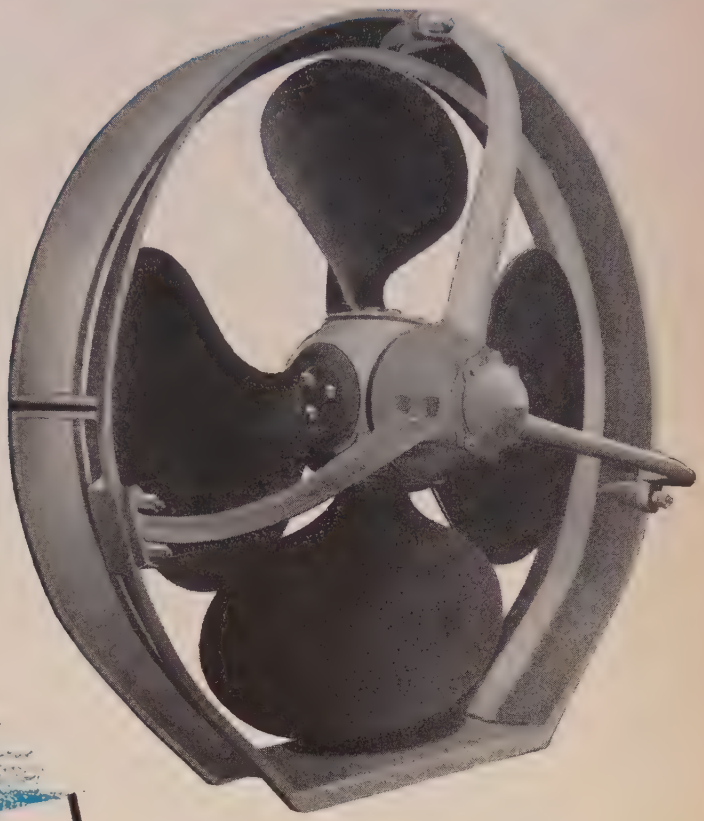

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IMPCO

Sherbrooke Machineries Limited manufacture similar equipment in Canada

Savings Resulting from the Installation of Pallet Systems—Baltimore Area

	Loading and unloading time	*Labor cost*	*Storage space*
Radio manufacturer	About the same	None	10%
Tool manufacturer	About the same	25% (internal only)	25–35%
Grocery warehouse	40%—trucks 25%—freight cars	50% 25	66⅔% ...
Railway warehouse	Considerable 40%	10–15% 40%	(None—ceilings too low)
Railroad	30%	25%	25%
Motor freight line (1)	Significant		
Motor freight line (2)	None	None	30%

A furniture manufacturer said he was able to halve his handling costs. Similar savings were recorded by soft drink distributors. Metal can officials in the Midwest reduced carloading time from 2½ to ¾ hr.

A Chicago fiber container manufacturer who receives and ships containers in a completely palletized operation, indicated that his deliveries were three times faster than the method previously used. A floor tile manufacturer in the same area eliminated a crew of handlers by palletizing 27 66-lb. packages at one time.

Daily production lines of a cosmetic manufacturer are set up in ½ hr. by one man. The old method required a full night's work for two men. This company is now endeavoring to have all in-plant shipments made on pallets.

Distributing stations were reduced from 70 to 11 by a manufacturer of farm equipment and consumer durable goods by the use of pallets. This has also had the effect of reducing spare parts inventories by two thirds.

Time and labor savings of 50% were accomplished in loading 40 cars of 60-mm. shells by a munitions maker with a recently installed pallet system. Savings realized by seven Eastern firms reporting to the Baltimore office are reflected in the above summary.

Industry representatives listed numerous reasons for not being able to fully utilize the pallet system. The most frequently mentioned limitations are discussed below with suggested remedies for some of them.

Inadequate warehouses were often mentioned as one of the chief obstacles for installing pallet operations. Older style warehouses were often constructed with low ceilings, weak floors, and limited aisle space. Several respondents throughout the country indicated they were planning future warehouses to take full advantage of the many potentials offered by pallets.

Reports indicate that railroad reluctance to grant freight concessions for the use of pallets has resulted in high freight costs. Inability of many concerns to fully utilize high cost fork trucks was also given as a reason for failing to install pallets. Lack of identical merchandise and merchandise not adapted to pallet operations were probably the chief deterrents when decisions were made by firms against palletizing. Many container manufacturers have solved these problems by designing containers to make irregular or small size merchandise adaptable to pallet use. It is apparent from the survey that many container manufacturers are continuing to overlook the possibility of offering this type service to their customers.

Most of the firms contacted report that the advent of palletization had no effect on the containers and packaging materials in current use. Several firms, however, reported that they had either strengthened or changed the structural design of their containers. For instance, an Illinois farm machinery producer expressed a preference for light wood boxes. He contended they were relatively strong and pilferproof for shipping his products on pallets.

Weakness of some corrugated shipping containers was reported by a Cleveland stevedore company. This same observation was also made by several railways and motor carriers handling palletized shipments. A grocery warehouse in the Midwest eliminated this weakness by using solid fiber boxes for shipping heavier items. Generally, however, packages are designed for the commodity and few complaints were received concerning structurally weak containers.

Lack of uniform sizes and square containers were by far the most frequently mentioned complaints received concerning the adequacy of containers for palletization. Rectangular shapes with the length at least 1½ times the width and height of the container were recommended. These dimensions make it possible for the load to be "bricked" or "locked" to prevent shifting.

The inability of industry to standardize both pallets and containers constitutes one of the biggest "bottlenecks" in bringing pallets from the warehouse and production line stage into the distribution channels. A materials handling expert of a large paperboard box company says, "This can be accomplished only when container manufacturers are willing to consider the complete system of shipping from the point of origin to the customer. To fully understand these implications they must consult with a materials handling man who may indicate necessary changes." It was his opinion, however, that his knowledge is increasing rapidly and at the present pace a general understanding would probably be reached in approximately 5 years.

The two examples below indicate how this container-pallet standardization "bottleneck" was solved. Early in World War II the tremendous shipping volume of the Brooklyn Naval Clothing Depot made it, almost overnight, one of the world's largest handlers of clothing. An entirely new approach was used to solve the momentous handling task. It was decided to fit the container to the pallet which was in

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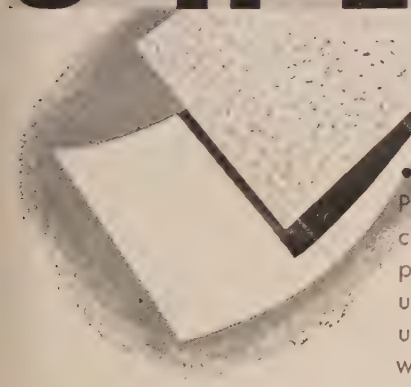

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turn fitted to the boxcar. Tens of thousands of 48 by 48 in. pallets were ordered. Containers were made for this size pallet. The results in labor and time savings accomplished were unbelievable. This study and solution illustrate how pallet construction can have a decided effect on both container size and construction. Further study of the problem has resulted in the entire military system now utilizing the 48 by 40 in. pallet in order to facilitate all commercial carrier shipments.

In the food industry, grocerymen used a similar program to bring about the best method of handling food shipments. Working in cooperation with the Commodity Standards Division of the Department of Commerce, they concluded that the following pallet sizes could be used to best advantage throughout their industry:

A 40 by 32 in. pallet for handling loads of 2000 lb. or less.
A 48 by 40 in. pallet for heavier loads.

Recommendations were also made for the most desirable container characteristics for grocery handling on pallets. They include:

1. Horizontal packages.
2. Containers of adequate strength—shipping cartons should be strong enough to permit 16-ft. stacks.
3. Packages should not exceed 50 lb. weight.
4. Packages containing light materials should not be over 4 cu. ft. in size; those containing heavy materials should not measure over 1 cu. ft. Heavy cases significantly smaller than this, i.e., baby foods, extracts, etc., should be glued or taped to meet these requirements.

The effectiveness of this program was repeatedly reflected in the recent Commerce Department survey taken in conjunction with this study. Grocery wholesalers were found to be the only distributors who had satisfactorily adopted this method of handling on an *industry-wide* basis. The enormous savings realized by this industry should point the way for a similar intelligent approach to the solution of materials handling problems in other industries.

No definite conclusions were reached on whether the installation of pallets resulted in increased or decreased container consumption. It was unanimously agreed, however, that the over-all change was negligible. Major changes were tailored to meet the requirements of a particular industry. For example, a traffic manager of a large electric corporation reported that installation of pallet operations definitely accounted for reduced container consumption. For instance, hydraulic brakes were formerly packed one to a corrugated shipping container; now the containers are eliminated and wood separators are used to protect the product. He also pointed out that a single large egg case type container was now used to ship 60 motors. This present-day package required 127 sq. ft. of fiberboard compared to the 665 sq. ft. formerly used.

A materials control superintendent of a large motor car corporation pointed out that pallets had decreased the amount of material received loose and naturally more containers would be used this way.

A well-known product developer for an expendable pallet company explained that his firm had made a spot check of this question through their customers. It was found that in 90% of the cases no containers were used at all prior to the adoption of expendable pallets. Containers were found to be more easily glued or strapped than the unpackaged commodity in order to be palletized effectively. In the case of castings he reported that they were formerly shipped loose with damage claims running around 10%. This far exceeded the cost of packaging used today. Similar examples of increased use of packaging were found in shipping automobile wheels, transmissions, paper bags, shock absorbers, springs, etc.

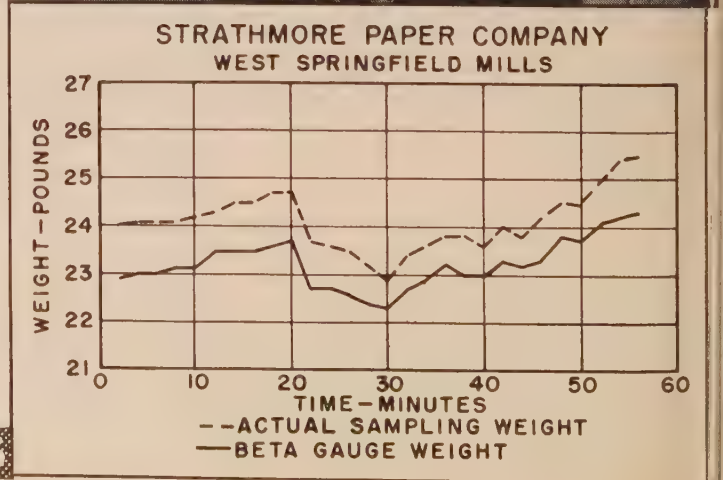
Reprinted from the September, 1952, issue of *Good Packaging*.

STRATHMORE Likes Tracerlab BETA GAUGES Because...

. . . they have found that their Tracerlab BG-1 gauge enables them to hold sheet weight to less than a 3% variation. As their machine operators gain confidence in the instrument, Strathmore feels that they may be able to reduce this figure.

This outstanding New England firm is always striving to improve quality for their customers, and the gauge was purchased primarily for this purpose. In addition to maintaining greater weight uniformity, however, Strathmore has found that the gauge has effected savings in raw materials. Other mills operating Tracerlab gauges have found that raw material savings quickly repay the gauge's low cost.

Upper picture shows Strathmore Beta Gauge installation; lower chart graphically presents an unexplained machine aberration noted by the gauge and recorder and confirmed by subsequent sample weighings. Minor discrepancies between curves are due to the difficulty of getting samples in exactly corresponding places.



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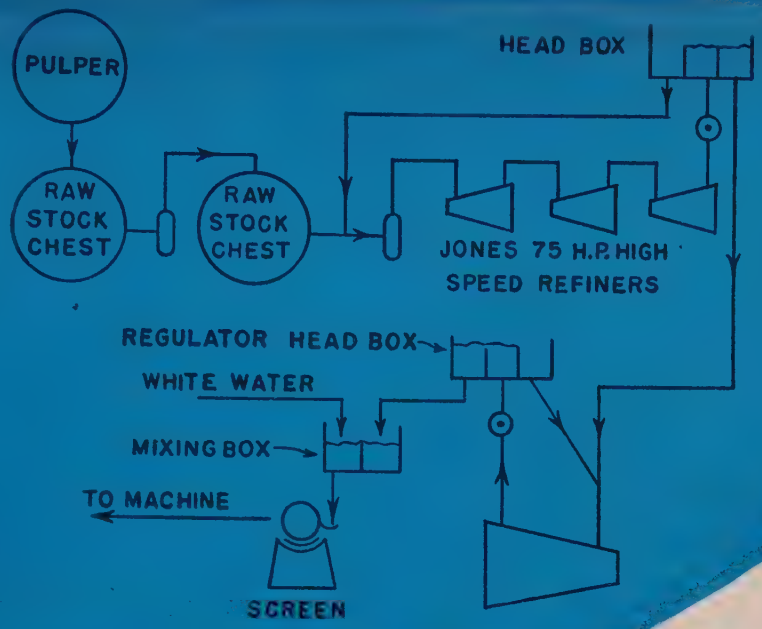
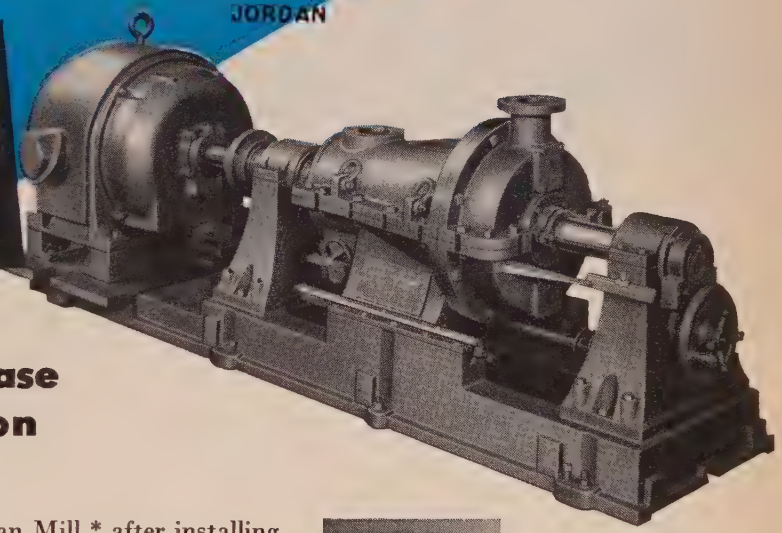


JONES 150 H.P. STANDARD JORDAN



Old installation 800 connected h. p.
New installation 375 connected h. p.
SAVING 425 h. p.

Plus 10% increase in production

That's the record of a 3-machine Mexican Mill,* after installing the Jones equipment shown in the flow-chart above.

Three Jones High-Speed Refiners and one Standard Jordan replaced two 250-h.p. refiners and two 150-h.p. Jordans when this mill modernized the stock preparation for its largest paper machine — making about 20 t.p.d. of sulphite bonds and 12 to 14 t.p.d. of manifold papers.

The new installation has increased production by 10% while producing equal or better quality papers. Why don't *you* find out what the Jones High-Speed Refiner can do for your cost and quality controls? Ask your Jones representative or write direct for Bulletin EDJ-1011B.

**Name on request*

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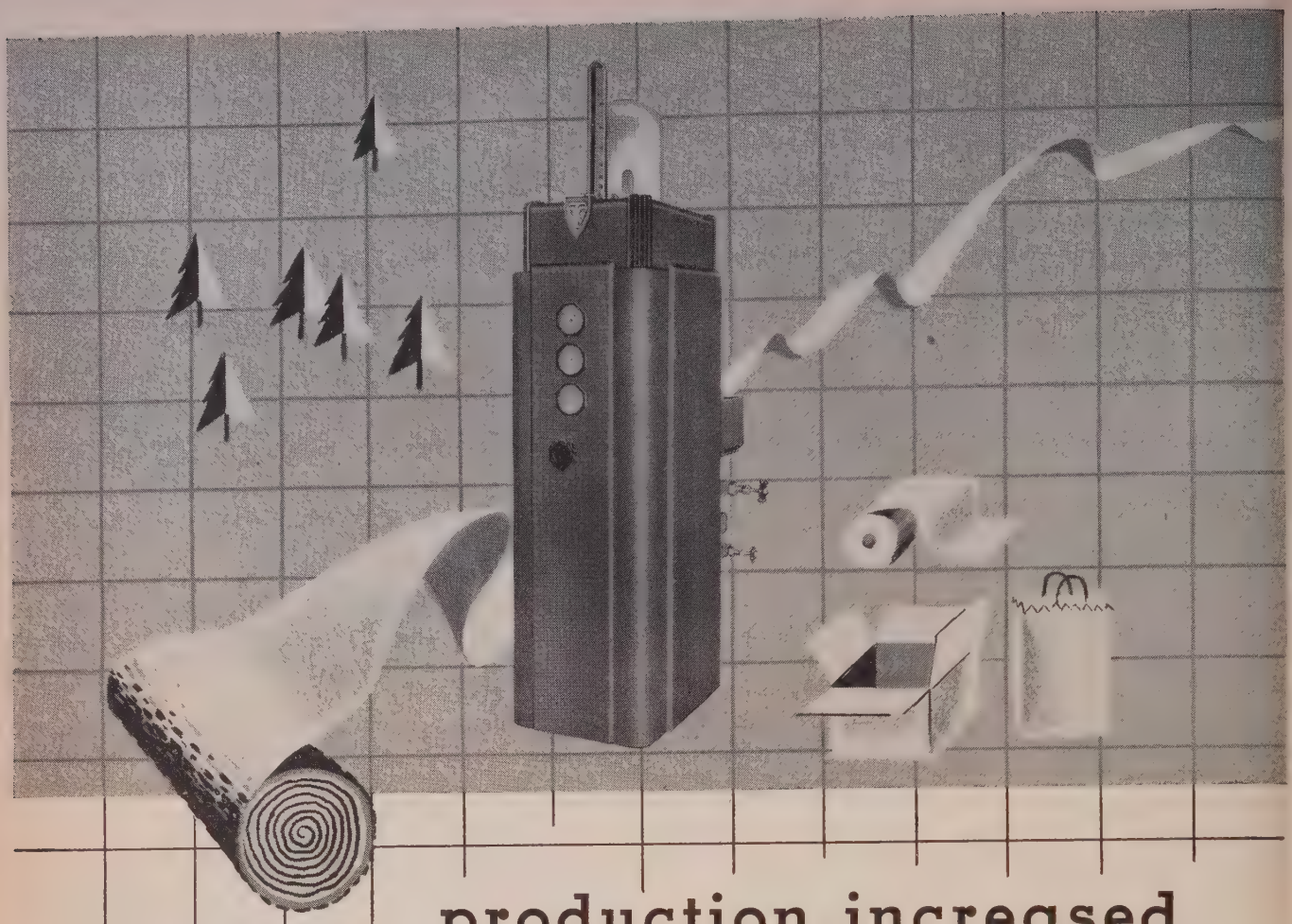

production increased up to 15 tons per day...

... with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in.
Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime!
Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

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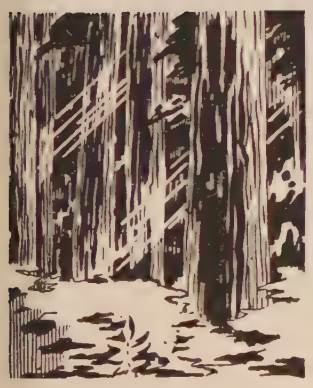
In the Weyerhaeuser long range timber growth plan, blocks of "parent seed trees" provide seeds for new growth trees which will supply a steadily increasing part of the harvest. As these second growth trees replace virgin timber, the science of tree growing will have to solve many new problems of forest management.

Looking to the future, Weyerhaeuser Timber requirements will be obtained from trees between 80 and 160 years old. To successfully accomplish this transition, Weyerhaeuser Forestry Research is constantly gathering more specific knowledge of tree growing habits and their relationship to fire, insects, disease and logging practices.



The soundness of the Weyerhaeuser sustained yield programs depends on the ability of its foresters to predict with reasonable accuracy the yield of these young forests. Based on these future growth figures, the productive capacity of the Pulp Division can be planned years ahead. As the quantity of the crops from these young forests increases, so will the quantity of Weyerhaeuser Sulphite and Sulphate pulps.

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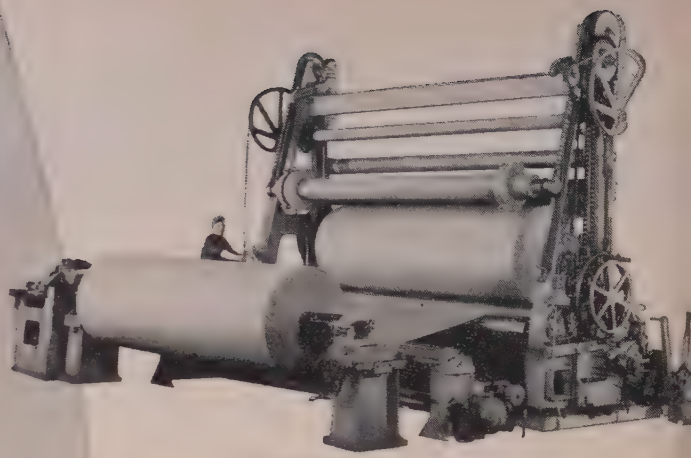

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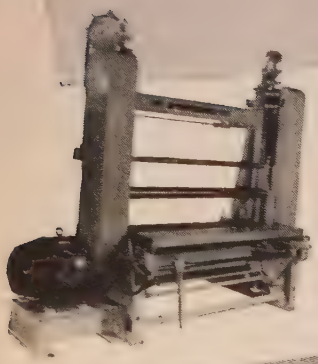
at lower cost

Camachine winders and slitters are built to keep downtime, repair and replacement costs at a minimum. Even when operating at Camachine's record-breaking speeds, vibration and consequent wear are virtually eliminated. And when normal wear calls for replacements Camachine's trained service department stands ready to speed the shipment of new parts. Ask your maintenance men and they will tell you why Camachines stay on the job!



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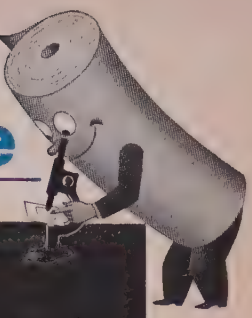

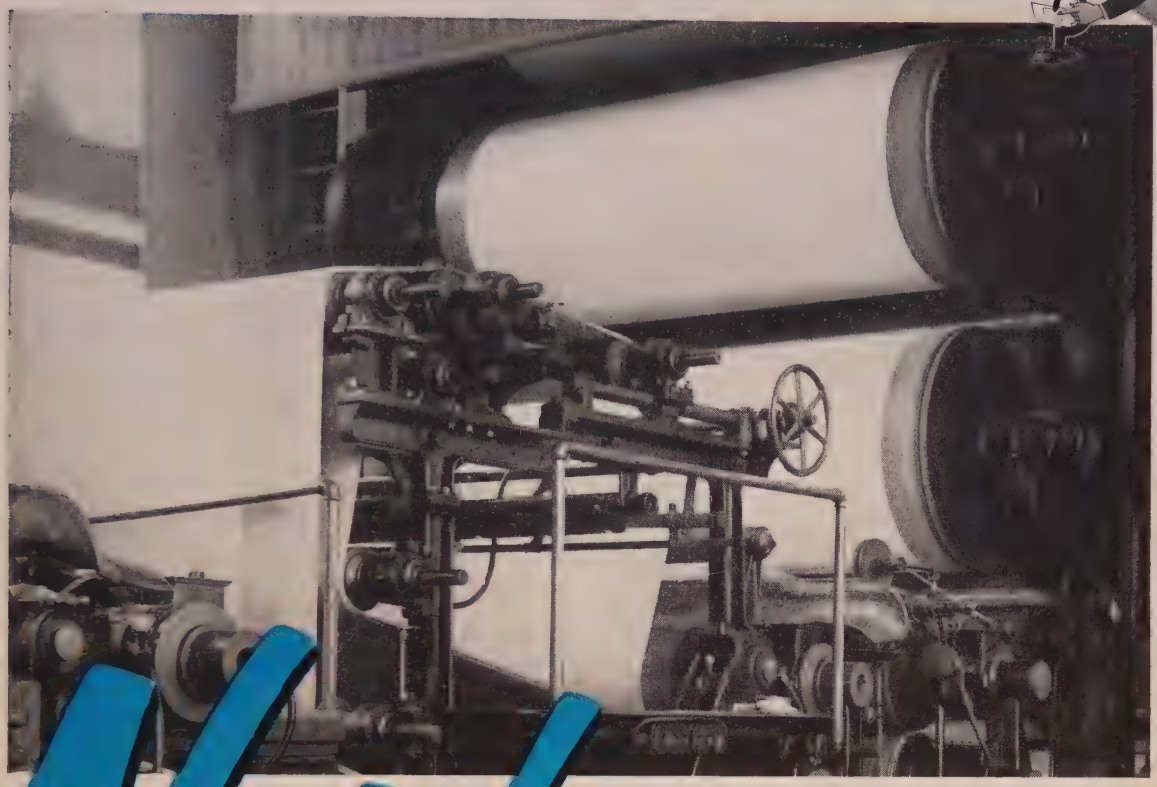

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YESTERDAY, TODAY, and TOMORROW

A. NEWELL RUMPF

It was suggested that some observations from an outsider looking at the pulp and paper industry would be acceptable as a topic for discourse. It has been my pleasure to follow your industry through being identified with bank financing of a good many mills in the central states area. The primary industry has become one of my main interests.

Primarily you are interested in the technical aspects of the product. A well-developed technical man must by necessity associate himself with broader elements of the industry if he is to ever make a complete contribution to his company and to the industry as a whole. The world is dependent on the products which result from your work; but, in order to bring about its complete fruition, there must be a flow of money and credit to your plant. The results determine the credit which will be available to your concerns and without credit you will be unable to produce and market your products.

It is hoped that a few of my comments will result in your taking an increasing interest in the administrative affairs of your respective companies. While this may necessitate a study required to understand, interpret, and evaluate balance sheets and profit and loss statements, it is my firm conviction that such time spent will be extremely worth while.

Prior to fairly recent times, each individual mill went its own independent way and it was difficult for the investment analyst to secure an over-all picture of the industry. That the need was present, is indicated by the result. Now we find many publications and studies on a continuing basis which are of great value in determining not only the position of an individual company but more particularly its relationship to the industry as a whole. There are numerous publications listing financial data on the paper industry and the following is representative but by no means complete:

1. Federal Reserve Board Index.
2. Census of Manufacturers—U. S. Department of Commerce.
3. U. S. Manufacturing Corporations—Federal Trade Commission and Securities and Exchange Commission.
4. Various publications of the American Paper and Pulp Association such as its monthly statistical summary, capital and income surveys, and other similar studies.

A comparison of the data of the paper industry with the over-all production index published by the Federal Reserve Board shows where we have been and suggests trends which may lie in the future. Through an intelligent study of these available tools, a good deal of the guesswork is removed in the determination of the course for future action.

A. Newell Rumpf, Vice-President, Harris Trust and Savings Bank, Chicago, Ill.

A dozen years ago, when I started observing your industry at close hand, I was told that it was regarded pretty much in the "prince and pauper" classification. However, over the years I have come to more fully recognize the vast economic improvements in the industry since its depression lows and question actually whether it should ever have been classified as a feast or famine business. Whatever its difficulties may have been in the past they were, I believe, more attributable to its mishandling of its corporate affairs rather than external factors. A sincere study reveals strong fundamental characteristics principally accounted for by its close affiliation with consumer goods. Accordingly, if soundly financed, a well-ordained growth trend is in order. Certainly, in the last decade, it has been a profitable investment for the owners.

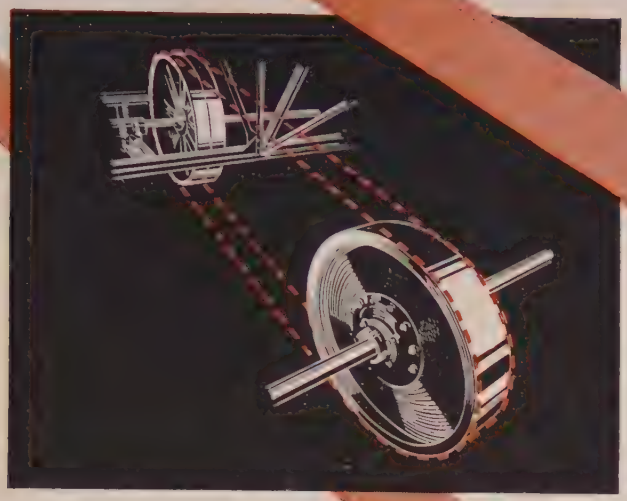
Let us look for a moment at the past. During the early depression years, the industry experienced difficult times. As suggested previously, a large portion of this resulted from within the industry rather than from external factors. Grade shifting appears to be an inherent characteristic and it was to be expected that mills finding themselves without orders in high profit items shifted downward in order to capture part of the market formerly dominated by competitors. Obviously this step was taken in an effort to cover overhead and burden. Downward pressure brought about the bankruptcy of marginal mills. With price cutting, irrespective of demand, it was no surprise to find a chaotic condition existing in the industry as a whole.

It is well known that the industry is characterized by a large fixed plant investment and resultant heavy overhead charges. Profits, if any, vary widely on relatively small fluctuations in operating rates. It should not be overlooked that many companies, 20 years ago, had heavy capitalizations with large debts and fixed charges which were burdensome when sales contracted. The largest unit in the industry, for example, had almost $200,000,000 of long-term debt and preferred stock at the end of 1937. It is interesting to note that its long-term debt has now been entirely eliminated and there is only a fourth of its preferred stock ($23,000,000) ahead of common equity today. Meanwhile, its sales have increased fivefold.

During the thirties, yearly operating rates ranged from 58 to 83% with an average of 72% of capacity for those 10 depressed years—actually, considering other industry classifications, a relatively good showing.

The period of World War II is familiar to all of us; with production materially behind demand and a belated recognition on the part of Government as to the essentiality of the product. It was not unexpected that, with shortages of raw materials all along the line, production ran behind capacity. The trend of produc-

your pulleys will drive your machines only as well as your belts drive your pulleys



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tion stabilized at around 17,500,000 tons during the war period, but shortly thereafter resumed the upward trend which started in the thirties.

The past 20 years have witnessed a more or less upward trend in paper consumption in the United States—1951 production at 26,100,000 tons compared with 8 million in 1932, 12.8 million in 1937, and 19.3 million in 1946. Hence, for the last 10 years, what with capacity expansions and increased demands, operating rates were at virtually capacity levels. At the same time, these high operating rates afforded a favorable internal leverage factor for the industry and net profits rose at an accelerated rate held down almost exclusively by price ceilings and taxes. This has enabled many companies to reduce substantially their funded debts and fixed charges while undergoing a substantial growth in total assets.

The following statistics reveal the favorable financial changes since 1939:

	1939	*1946*	*1951*
Total assets, billions	$ 2.36	$ 3.28	$ 6.60
Long-term debt, millions	N.A.	N.A.	$885
Net worth, billions	$ 1.70	$ 2.42	$ 4.40
Net sales, billions	$ 1.45	$ 3.55	$ 7.22
Federal taxes, millions	$ 18	$208	$982
Net earnings after taxes, millions	$ 84	$302	$577
Per cent of net earnings to net worth	5.0%	12.4%	13.3%
Per cent of net earnings to sales	5.8%	8.5%	8.0%

N.A.—not available.
Source: American Paper & Pulp Association.

Per capita consumption of paper has shown a most interesting use trend. Even you who make your living in the pulp and paper industry are surprised at the individual annual consumption which is reliably reported at 396 lb. in 1951. In 1902, which I would judge is close to the average birth date of your group, the figure stood at about 65 lb. and has risen almost without interruption over the half century. Some years ago, the *Paper Trade Journal* carried on its title page the statement: "The consumption of paper is the measure of a people's culture." Certainly this holds true in America where our usage is more than double that of any other nation with the exception of Canada.

You will recall that last year a note of pessimism was given. This was because the relation of production to basic demand indicated that output was ahead of actual usage. Orders received were less than productive capacity. On a short-term basis, while it appeared that over-all production was on a pretty firm level, nevertheless, over a longer term it was felt that a period of digestion was in order.

Now where do we stand on Oct. 20, 1952? The picture is not as pleasant as it has been during the last 10 years. The latest figures indicate that total paper production is 88.6% of rated capacity. This compares with 99.5% for the corresponding week of 1951. For paperboard the most recent figure stands at 94.0% compared with 90.0% in the same week last year. A comparative showing with 1950 is poorer.

The reasons are largely known to all. At the time of Korea, the shortages of World War II were fresh in the minds of all paper consumers with the result that a rush of buying was instituted. A large segment of this order placing was of a hoarding nature. When it became apparent that paper was not in short supply, and when inventories generally were pyramided at the manufacturing and distributing level, a wave of cancellations and retrenchment took place. The first to feel the change were the paperboard producers. This in spite of a near record peak of over-all manufacturing. Next to feel the reduction in demand were the tissue mills indicating that in spite of high national income the pipelines all along the line were filled. I am reminded of a small bank with 27 employees which I visited last March. In the basement I noted 12 cases of toilet tissue taking up valuable space. I don't know the rate of consumption of this group, but I am inclined to feel that more than one year's supply was on hand unless they planned to use it in a shortage as an inducement to get new accounts. I am also inclined to believe that buying habits have changed in this field and perhaps case purchasing is larger than generally believed.

If I read the history of your industry correctly, the current dip is either considered to be of short duration or the industry is much better financed. Formerly, price cutting would already be in full swing but I am told that outside of a few instances prices have held firm in spite of lowering sales volume. Let us hope that, if price cutting is freely instituted, it will remain orderly. Also, some segments have remained in good statistical position.

It is to be noted that in recent months the gap between production and demand is closing. Based on industry contacts I believe that the recent excess inventories in the hands of paper users have been liquidated and look for a renewal of the basic strong demand for paper products from here on out. A favorable factor is the recent revival in activity in paper-consuming industries such as the textiles. It is quite apparent that there was over-buying and over-production in the first half of 1951 and under-buying and under-production in the first half of 1952. This situation was mainly in the more volatile paperboard division. After a slow first half, I expect total paper and board production in 1952 to be somewhere between 24½ to 25 million tons which would compare with 26 million in 1951 and 24.4 million in 1950.

Unlike other segments of the industry, newsprint production and consumption have shown no temporary decline. Canadian newsprint production of 3.3 million tons for the first seven months of 1952 was up 3.4% over 1951 levels and even United States production of 683,000 tons was up 6.0% from the comparable 1951 period. More important, United States newsprint consumption of 3,467,000 tons was up 1.1% over the first seven months of 1951.

The recent decline in Canadian and Scandinavian pulp prices has made good press copy. However, the truth of the matter is that these prices were on the high side a year ago as a reflection of the abnormally strong pulp demand. For example, Scandinavian bleached sulphite pulp was at $250 to $300 a ton in early 1951 and Canadian pulp was $155 to $160 a ton as compared to $145 for domestic pulp. Now both of these pulps have come down to meet the more realistic (and consistent) domestic price. Effective June 16 a price increase of $10 a ton was posted on all newsprint

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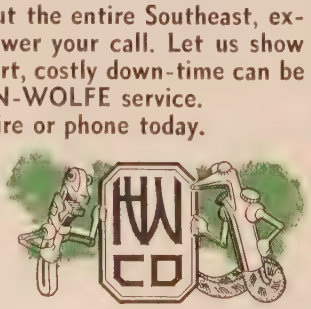

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manufactured in Canada, raising the price to $126 a ton (New York). The reason for this increase was to offset the rise in production costs and also to offset the loss on exchange due to the lower value of the United States dollar in relation to the Canadian dollar. Over-all paper and board prices are more or less in line with other commodity prices. For example, as compared with the Bureau of Labor Statistics Wholesale Commodity Price Index of 111.3 for June, 1952 (1947–49—100) the index for paper (exclusive of newsprint) was 114.0, paperboard was 130.5.

Recently the *Wall Street Journal* reported earnings of 21 paper manufacturers off 21% for the second quarter of 1952. In an effort to satisfy myself on the report, I have taken 14 profit and loss statements of a cross section of your industry and compared them with the figures of a year ago.

The quarterly sales figures were taken from Moody's and therein were reported to be those which are submitted to the SEC. The net profit statistics were also derived from Moody's for the most part; however, it was frequently necessary to compute quarterly results from the cumulative data that are published by some of the companies. Regarding those net profit figures, it should be recalled that Federal tax rates were increased during the latter part of 1951 and some retroactive adjustments were made necessary. As a consequence, many companies found it necessary to subsequently adjust the profit results for the first two quarters of 1951. The extent of these adjustments will not become known until the quarterly results for the current year (with comparative results for last year) have been published. Further adjustments may be necessary as results for the final two quarters of 1952 become available. All net profits are after taxes.

The lower volume of activity experienced by most paper companies this year is noticed in the comparisons of recent operating results. Aside from Scott Paper Co. (whose results this year include Soundview Pulp Co.), Nekoosa-Edwards was the only one of 14 companies whose sales were greater in the second quarter of 1952 than they were during the same period in 1951. Among the other companies, West Virginia Pulp & Paper Co. and Kimberly-Clark came the closest to approaching last year's volume. Mead, St. Regis, and the three container companies (Gaylord, National, and Container Corp.) each experienced a second-quarter volume which was at least 9% lower than that of the previous year.

Sales results for the year to date (first half) generally indicate that the first quarter was relatively better than the second quarter for most companies. The sustained demand for white papers, through the first quarter of the year, is particularly well reflected in the comparative results for Hammermill, West Virginia and Nekoosa-Edwards. Each of these three had sufficiently satisfactory first quarters to make their respective sales for the entire first half greater than those during the comparable 1951 period. International Paper's sales for the first half were also slightly greater than those of last year.

With respect to net profit results, the leverage which is present in the paper industry was clearly reflected by the relatively greater declines which occurred in profits than was true in the case of sales. Higher

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Paper Company Operations

Company	Year	Sales (000s) First quarter	Sales (000s) Calendar year quarters[a] Second quarter	Sales (000s) Calendar year quarters[a] Third quarter	Sales (000s) Fourth quarter	Net profits (000s) First quarter	Net profits (000s) Calendar year quarters[a] Second quarter	Net profits (000s) Calendar year quarters[a] Third quarter	Net profits (000s) Fourth quarter	Comparisons (Current vs. preceding year) Sales Most recent quarter	Comparisons (Current vs. preceding year) Sales Year to date	Comparisons (Current vs. preceding year) Net profit Most recent quarter	Comparisons (Current vs. preceding year) Net profit Year to date
West Virginia P. & P. (Oct. 31, fiscal year)	1951	$ 28,672	$ 29,480	$ 31,011	$30,763	$ 2,920	$ 2,387	$ 2,343	$2,564	— .6%	+1.8%	+2.5%	+2.1%
	1952	29,899	29,303			2,971	2,446						
Mead Corp.	1951	26,018	26,253	33,369	26,391	1,617	1,495	1,683	1,314	−11.1%	−6.4%	−24.6%	−25.4%
	1952	25,577	23,332			1,195	1,127						
Hammermill Paper	1951	7,272	7,452	7,181	7,571	449	479	358	430	−2.7%	+8.7%	−33.6%	−24.7%
	1952	8,750	7,255			381	318						
Nekoosa-Edwards	1951	5,818	6,045	5,759	6,003	580	455	273	524	+.9%	+7.8%	−4.8%	−11.1%
	1952	6,689	6,100			487	433						
Kimberly-Clark (April 30, fiscal year)	1951	39,560	38,562	40,166	38,165	3,269	2,775	2,748	3,390	−.8%	−3.8%	−19.5%	−23.4%
	1952	36,896	38,271			2,394	2,235						
Scott Paper Co.	1951	30,189	31,632	30,070	35,218[b]	1,603	1,827	1,053	N.A.[b]	+10.8%	+17.6%	+30.8%	+43.3%
	1952	37,668	35,036			2,527	2,389						
Marathon Corp. (Oct. 31, fiscal year)	1951	24,492	23,272	23,479	20,022	1,897	2,533	2,467	1,905	−5.5%	−8.8%	−39.0%	−28.9%
	1952	21,578	22,000			1,606	1,544						
Sutherland Paper Co.	1951	13,478	13,069	11,410	9,844	814	840	411	583	−1.5%	−7.9%	−25.5%	−27.7%
	1952	11,563	12,873			569	626						
International Paper	1951	151,379	164,215	161,043	167,465	14,264	14,463	13,875	14,217	−6.2%	+.9%	−19.7%	−15.2%
	1952	164,499	153,965			12,747	11,623						
Crown Zellerbach (April 30, fiscal year)	1951	61,345	60,574	63,485	61,821	7,623	5,995	5,936	6,070	−2.2%	−1.5%	−14.1%	−17.7%
	1952	60,815	59,260			6,057	5,150						
St. Regis	1951	48,394	52,272	45,413	49,877	4,836	4,453	3,608	3,999	−14.5%	−8.2%	−42.8%	−34.9%
	1952	47,697	44,684			3,505	2,545						
National Container	1951	19,092	20,101	16,199	15,431	2,928	2,942	1,767	981	−37.2%	−35.8%	−64.8%	−63.7%
	1952	12,544	12,635			1,096	1,035						
Container Corp.	1951	58,112	59,243	48,596	46,611	3,996	3,530	1,989	2,551	−28.6%	−25.8%	−28.5%	−29.6%
	1952	44,774	42,258			2,778	2,526						
Gaylord Container	1951	20,899	22,685	18,223	22,563	2,107	2,253	1,885	2,471	−9.9%	−2.3%	−26.5%	−17.3%
	1952	22,148	20,443			1,945	1,657						

[a] Companies not on a calendar year basis are scheduled on a basis that corresponds with the calendar year as nearly as possible.
[b] Scott Paper Co. acquired Soundview Pulp Co. on November 9, 1951—results thereafter reflect consolidated results.

costs without compensating pric increases were, of course, als influential. Aside from Scot Paper Co., West Virginia Pul & Paper was the only one of th group whose earnings during th first two quarters of 1952 wer greater than those of the pre ceding year. Nekoosa-Edward was the only other compan whose earnings for the first ha were not at least 15% below thos for the same period in 195 Six of the companies had firs half earnings which were mor than 25% below those of las year.

So much for yesterday and to day. What of tomorrow in th paper industry? I claim no in fallible crystal ball. Although am a member of the fraternity of optimists who would rathe be wrong than pessimists wh are right, there are three fac tors—which are by no means ex clusive to the paper industry— which give concern to the banke when viewing the future. I refe to taxes, cost of replacement o machinery, and expansion.

The impact of Federal incom taxes on the industry acquire terrific force in 1951. At the peak during World War II, the amounted to 9.1% of sales, 11.6% of net worth, and 8.3% of tot assets. In 1951 they were 13.1% of sales, 21.6% of net worth and 14.4% of total assets. Whe income and profit taxes tak over 21% of net worth again 5.9% for dividends and whe these taxes take more dolla out of the paper industry tha was paid in wages, it would ap pear that the industry is bein bled white and it is time t check Government expenditures

As is well known, a high in vestment per ton of output involved in the industry. Th APPA indicates a property a count of $3076 million at the en of 1951 with 212,000 worker This results in a $15,000 in vestment per employee. Tot assets per employee approxima $31,100 while the sales per em ployee amounted to $34,10 With the high cost of new equi ment to increase productivit normal depreciation standar are insufficient and must be m out of new capital. This high co restricts new entrants to the fie

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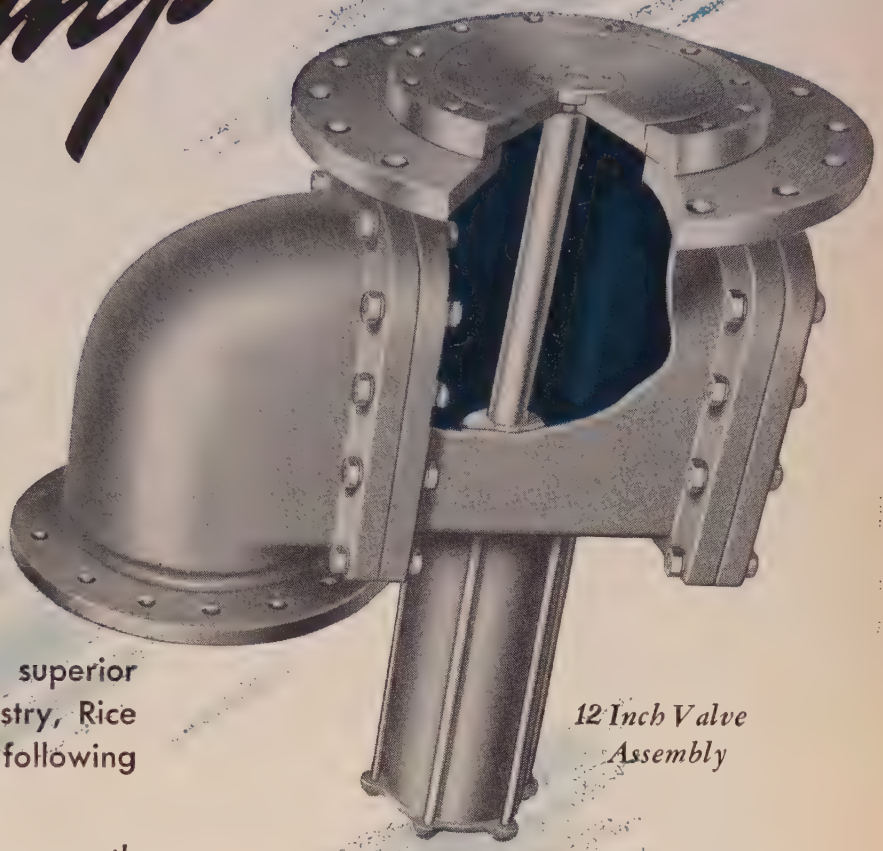

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Planned new capacity through 1955 is 2,304,000 tons over December, 1951. Of this, 1,033,000 tons is paper and the balance, board. This represents a 12 and 15% increase, respectively, over 1950 to a total of 27,750,000 tons. Some of this may be canceled or delayed, but one is prone to wonder if it can all be put to profitable use. Surely, if our income system cracks, there will be pressures to move products by present lower cost producers.

The paper industry is not only one of the oldest but one of the largest—ranging as it does in sixth position among the larger businesses in our country. Primary production last year was in excess of $6,000,000,000.

Someone has said that it is the third most used product in America today following water and milk.

America with 6% of the world's population consumes 68% of the world's production of paper products. It produces 58% of the total of paper and paperboard. It is by no means a static industry! It is sixth largest among manufacturing classifications.

A study made by the Federal Trade Commission reveals that 103 paper and allied products corporations showed the following rate of return (after taxes) on stockholder investment: 9.6% in 1940, 21.1% in 1947, 18.2% in 1948, 12.1% in 1949, 16.1% in 1950, and 18.3% in 1951. Only industrial chemicals, office and store machines, motor vehicles, electrical machinery and equipment businesses did better. It would appear that the industry and its stockholders are in good company.

During the past 10 years the paper industry has come to be considered by the investing public as an industry in which satisfactory investments can be made. Like all other industries, the paper industry offers investment opportunities that may vary company by company, but taking the industry as a whole, its record will bear analysis for years back as well as during the post-war periods.

The paper industry earnings record, taken as an industry, will stand up with "all industry" earnings in depression as in prosperity, for in fact, the paper industry has operated more steadily in depression periods than most industries. In the low year of the great depression (1932), the paper industry was operating at 58% of capacity, while steel was almost flat on its back below 20%, and banks dependent upon the automobile industry were in distress.

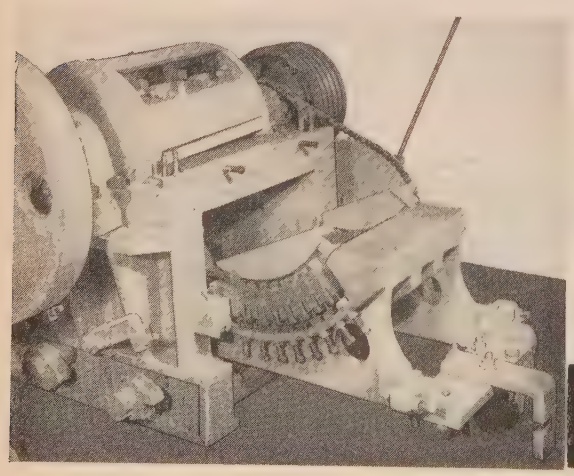
The paper industry is, of course, a service industry, and it therefore is dependent upon general business activity for its own activity. But it must be remembered that whatever business is done demands the use of paper as a necessity. *Business cannot be done without paper!*

If the prophets in Government and private industry are right, the United States is going to be a mighty big and zestful place to live in in 1975. Population will number about 193 million up 42 million. All this will mean far more need for paper products.

There is another factor which people usually overlook, namely, there is presently no economic substitute for paper or paperboard. On the contrary, paper and paperboard are the economic substitutes for wood, tin plate, glass, metals, textiles, and a host of other raw materials. Take the frozen food industry as an example. Clark Everest of the Marathon Corp. in a recent talk to some of his sales organization, made the remark that within five to ten years a June bride would have to go home to mother to find out about the fine art of manipulating a can opener. This may be a bit exaggerated, but in the main it is true. People are living out of refrigerators with a limited number of cubic feet capacity. The tendency is toward rectangular packages; round containers take up too much room. Airlines led the way with prepared meals which were prepackaged and practically all in paper, and now some railroads are following this procedure for dining car service. It is probable that this will be extended to thousands of homes. This all means the use of more paper and paperboard in many divisions—from the papers used for advertising, packaging, wrapping and paper cups, to the corrugated boxes in which the products are delivered.

There is not a single industrial or commercial activity which is not dependent on paper. In fact, from "birth certificate to death certificate" every child born in this country is a potential customer for some kind of paper or paper product.

Presented at a meeting of the Chicago Section of the Technical Association of the Pulp and Paper Industry, Chicago, Ill., Oct. 20, 1952.



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Based on a series of trial runs, the operating conditions for the CHEMI-PULPER continuous digester were determined and the operation was placed on a 24-hour basis.

High yield kraft pulp in the 60-62% range was produced from a mixture of spruce and balsam woods. The pulp passed through hot stock refiners—over a vacuum washer—through the board machine disc refiners and onto the liner board machine. The liner board was made from 100% CHEMI-PULPER continuous digester kraft pulp at the usual mill operating speed and tested somewhat higher than the minimum requirements for .016 liner.

The CHEMI-PULPER continuous digester can produce kraft pulp continuously at a considerable *saving in steam and manpower* requirements, and at a *better uniformity* which is an inherent characteristic of a continuous process as compared to a batch operation.

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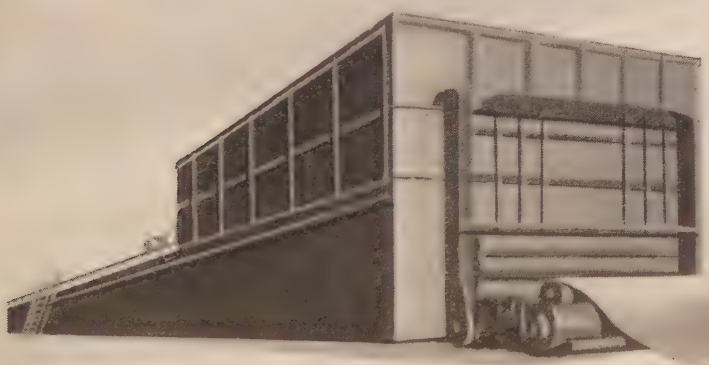

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One of the three big reasons why papermen prefer Swift's new process Glue

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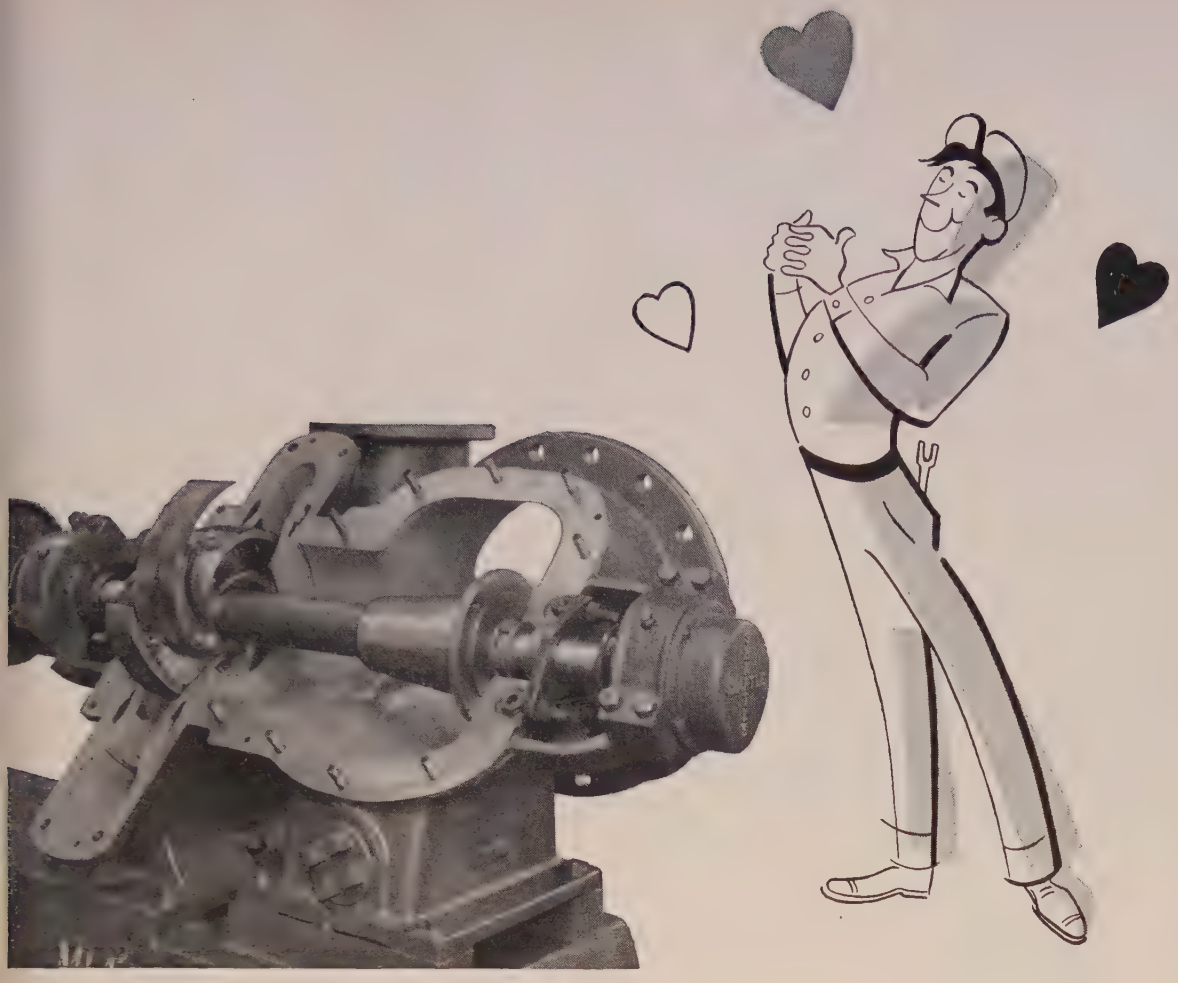

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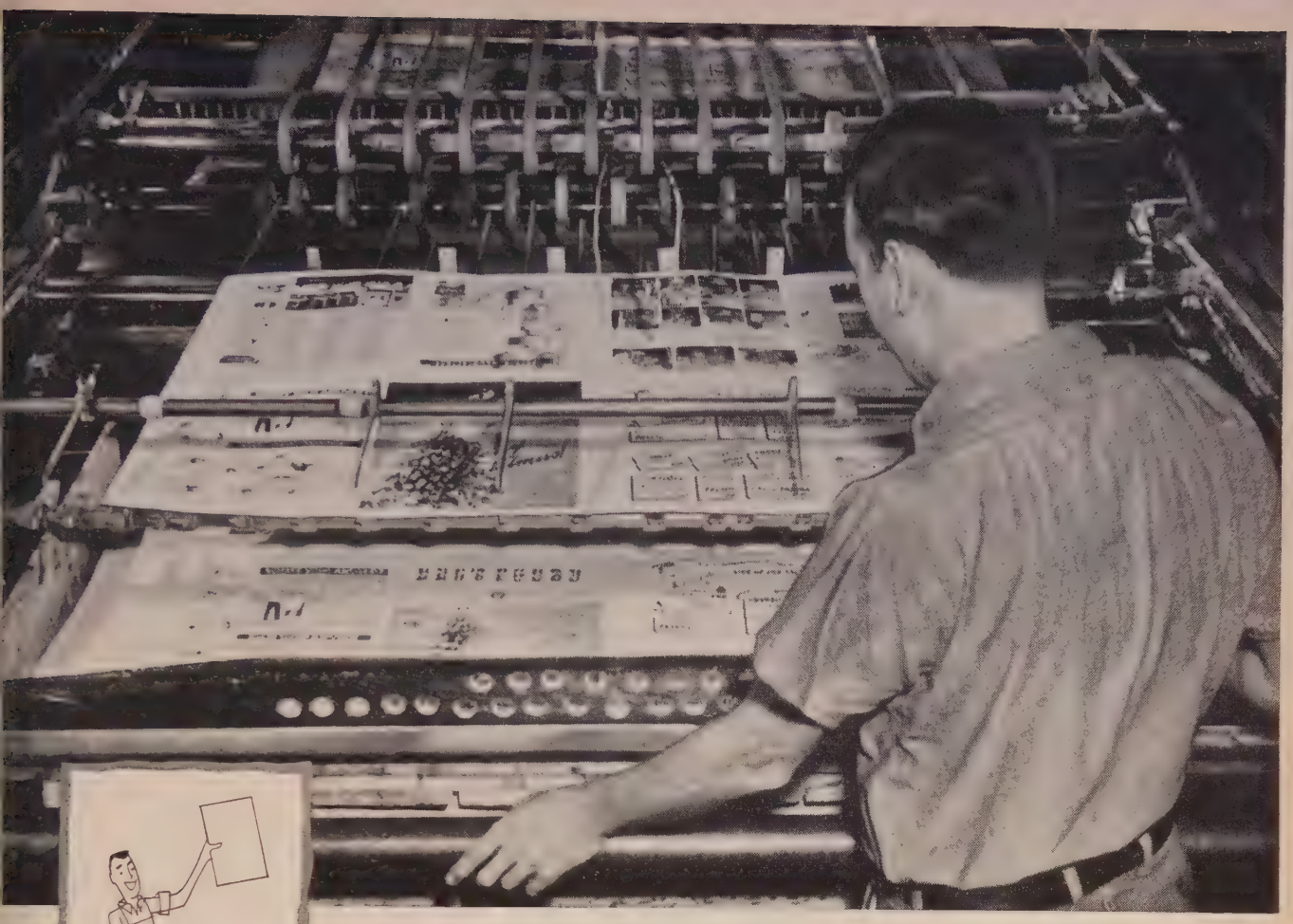

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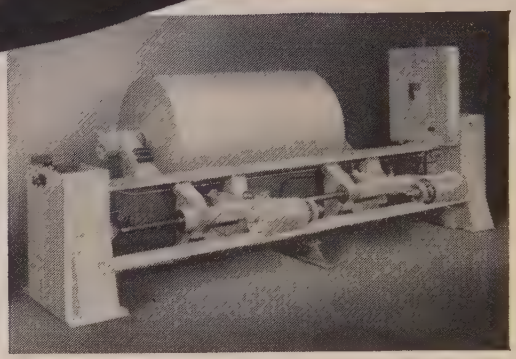

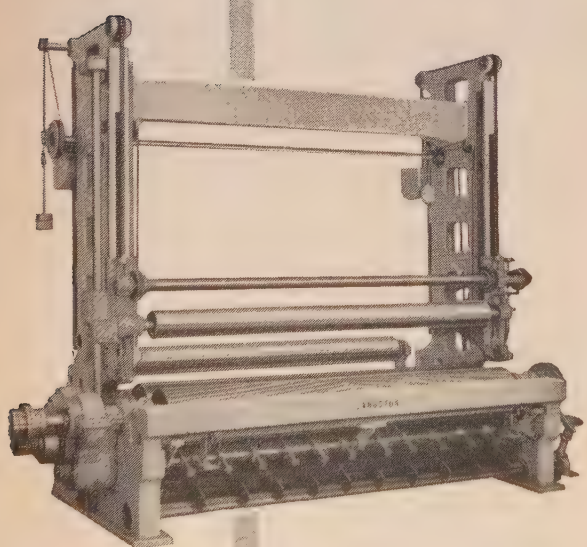

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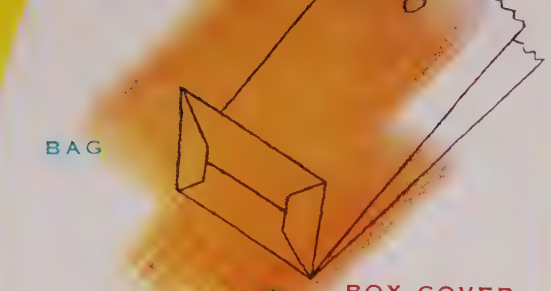

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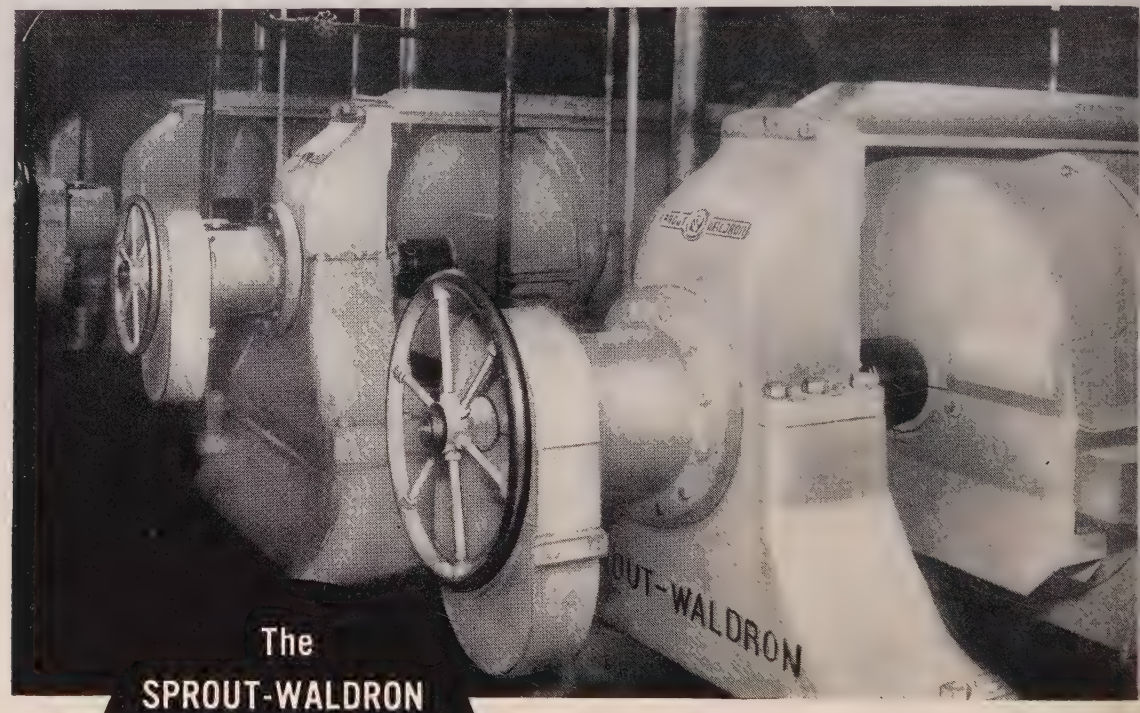

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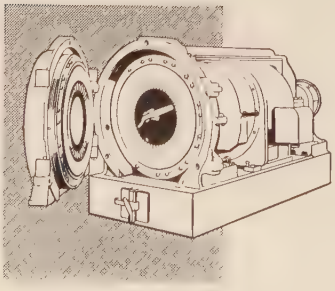

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An Analysis of Data on Stock Flow in Pipes

RICHARD E. DURST, ANDREW J. CHASE, and LYLE C. JENNESS

A mathematical analysis of the Brecht and Heller, Forrest and Grierson, and Cameron data on head loss due to pipe friction in transporting pulp stock suspensions has been made. The proposed correlation based on the Brecht and Heller data for unbleached sulphite pulp used a plot of a friction factor versus a pseudo-Reynolds No. (Re′ number) defined by the equation;

$$\frac{\Delta H_f D}{u^2 L} = f = \phi\left(\frac{D^{0.2} u \rho}{C^{1.16}}\right)$$

This relationship holds for these data within ±7% for all consistencies, and for velocities below a value in feet per second equal to the consistency in per cent raised to the 1.2 power. The head loss variation due to the type of stock may be predicted by correcting the calculated head loss for unbleached sulphite by the factors; bleached sulphite 0.88; unbleached straw 0.45; bleached straw 0.90; groundwood 1.42; cooked groundwood 1.0; and sulphate 0.90. Based on the Brecht and Heller correlation the Forrest and Grierson and Cameron data appear as curves paralleling the Brecht and Heller curve on the friction factor plot. Using these curves the data of Forrest and Grierson and Cameron may be predicted within the limits of ±25 and ±50%, respectively. The Brecht and Heller data relating freeness to head loss showed that freeness has less effect than the deviation of ±7% in the proposed correlation. A correction for freeness, therefore, does not seem feasible at this time. Also temperature, within the range of 18 to 35°C., does not affect the head loss beyond the accuracy of the correlation.

THE transportation of solids suspended in a fluid medium is an operation of wide application in the process industries. The pulp and paper industry is in the top bracket of those employing this operation from the viewpoint of volumes of material handled. And due to the wide divergence in the properties of the pulp stocks as well as variations that occur during the transportation of a given stock under different conditions of consistency and velocity there has been no basis for a coordination of the accumulated data on the behavior of stock flow.

Limiting our discussion to the flow of stock in pipes and giving our attention to the frictional head loss or pressure drop we find considerable data have been compiled by various independent workers (*1–11*). For various reasons there has been little effort on the part of the investigators to establish a standard experimental system. In some cases only a few of the variables were defined making it difficult if not impossible to compare experimental results. There is a need for more extensive knowledge of the flow properties of pulp stocks. A correlation of the existing data on the friction loss seemed to be an important and a necessary study as a foundation for future work.

The purpose of this investigation was to make a mathematical analysis of the existing data on friction loss of pulp stock flowing in pipes and to derive a correlation which would be useful in studying problems involving pulp flow. It was proposed that the investigation should start with a study of the Brecht and Heller data (*1*).

If we assume that these data present the friction loss in pipes for the various stocks studied including the variables, velocity, consistency, pipe diameter and roughness, temperature, and freeness we may then search the data for a correlation which will simplify the information presented. It has been recognized by various investigators (*1, 2, 6*) that stocks of low consistency, below about 1.4% moisture-free stock, have friction losses less than those for water at the same velocities Disregarding this range of consistencies and considering only that range between 1.5 and 5.0% studied by Brecht and Heller for unbleached sulphite pulp it was recognized their data are presented as nearly parallel curves where the consistencies are plotted as parameters with head loss and velocities as coordinates on logarithmic paper (Fig. 1). The part of the curves below velocities of about 8 ft. per sec. indicates that the data should be amenable to correlation. In the higher velocity range, over 8 ft. for low consistency stocks and 15 ft. per sec. for higher consistency stocks, the curves tend to indicate a flow pattern defining a turbulent type flow.

The classical analysis of the flow of Newtonian fluids cannot now be applied to suspensions of pulp in water due to our inability to measure the viscosity of this particular type of suspension. One investigator (*8*)

Nomenclature

Symbol	*Definition*	*Units*
ΔH_f	Head loss due to friction	Feet
D	Internal diameter of pipe	Feet
u	Average velocity of stock flowing	Feet per second
L	Length of pipe	Feet
C	Consistency of stock	$\frac{\text{Mass of moisture-free stock}}{\text{Mass of suspension}}$
Re′ no.	Pseudo-Reynolds number	$\frac{\text{Lb.-ft.}^{m-2}}{\text{Sec.}} \cdot \frac{(\text{Lb. suspension})^n}{\text{Lb. moisture-free stock}}$
ρ	Density of stock	Pounds per cubic foot
m	Exponents of D-term in Re′ no.	.....
n	Exponent of C-term in Re′ no.	.....
f	Symbol representing $\Delta H_f D/u^2 L$	$\frac{\text{Feet H}_2\text{O Second}^2}{\text{Square feet}}$
K	$(\Delta H_f)_{max.}$ for 100 ft. of pipe (Brecht and Heller data)	$\frac{\text{Feet}}{\text{100 feet pipe}}$
V	Velocity (after Peterson)	*Svensk Papperstidn.* 52
S	Consistency (after Peterson)	*Svensk Papperstidn.* 52

RICHARD E. DURST, Associate Professor of Chemical Engineering; ANDREW J. CHASE, Assistant Professor of Chemical Engineering; and LYLE C. JENNESS, Professor and Head of Department of Chemical Engineering, University of Maine, Orono, Me.

defined an apparent viscosity and obtained a correlation of certain data from which a nomograph was prepared for quickly estimating the friction loss when handling a known pulp suspension in a piping system. Application of the nomograph to the Brecht and Heller data gave very unsatisfactory results in predicting head loss values when compared with the observed values.

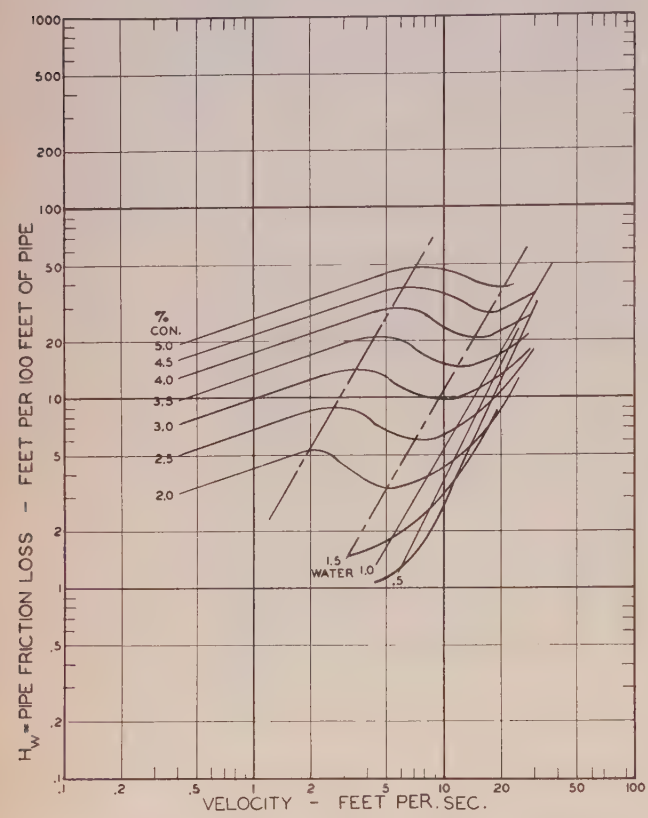

Fig. 1. Friction loss vs. velocity for various consistencies, unbleached sulphite pulp—828 S. R. freeness, 5.90-incl. copper pipe after Brecht and Heller

A further correlation which has some applications for sulphite pulp at low velocities was that devised by C. W. Peterson (*11*). That correlation makes use of a pseudo-Reynolds number, whose terms are $V\rho/S$, the consistency term replacing the usual viscosity term. Peterson found that a diameter factor was needed which in turn was equal to the diameter of the pipe and therefore the diameter dropped out of his correlation. The relationship yields head loss values which deviate by $\pm 35\%$ from the observed head loss in the so-called laminar flow region. In the turbulent region, someplace beyond the first maximum in the head loss curve as presented by Brecht and Heller (*1*), Peterson claims (*11*), "the viscosity of the suspension equals that of the suspending medium and for these velocities the normal Fanning Friction Factor equation can be used." Check calculations made using the Peterson correlation in the turbulent zone have not given head loss values in agreement with the observed experimental results of Brecht and Heller.

DERIVATION OF A PROPOSED CORRELATION

An inspection of the family of curves showing the head loss versus velocity in the pumping of unbleached sulphite stock, as plotted by Brecht and Heller (*1*) suggests that a correlation of the data should be possible in the region through the first maximum and extending on to the first minimum in the curves.

The first correlation developed in the course of this investigation depended upon a knowledge of the value of the head loss, ΔH_f at the first maximum in the head loss curve (Fig. 1). The data were calculated and plotted on log-log paper with the coordinates, $\Delta H_f D/u^2 L$ versus $u/D^{0.71}K^{0.6}$ (Fig. 2), where K was the head loss at the first maximum, in feet of water for each 100 ft. of pipe. The diameter exponent tended to reduce the data to the narrow band of points plotted in Fig. 2. This correlation did not include a term for the pulp consistency. Neither could it be used to calculate head loss without experimental knowledge of the $\Delta H_{max.}$, (K). It did, however, suggest that the data could be reduced by using a pseudo-Reynolds number.

The Pseudo-Reynolds Number and the Brecht and Heller Correlation

The inability at the present time to measure the viscosity of pulp suspensions and the fact that non-Newtonian suspensions appear to have a varying viscosity depending on consistency, pipe diameter, and pumping velocity prohibits the use of the dimensionless Reynolds number. We propose to replace the viscosity term in the Reynolds number with a consistency term after the manner of Peterson (*11*). The re-

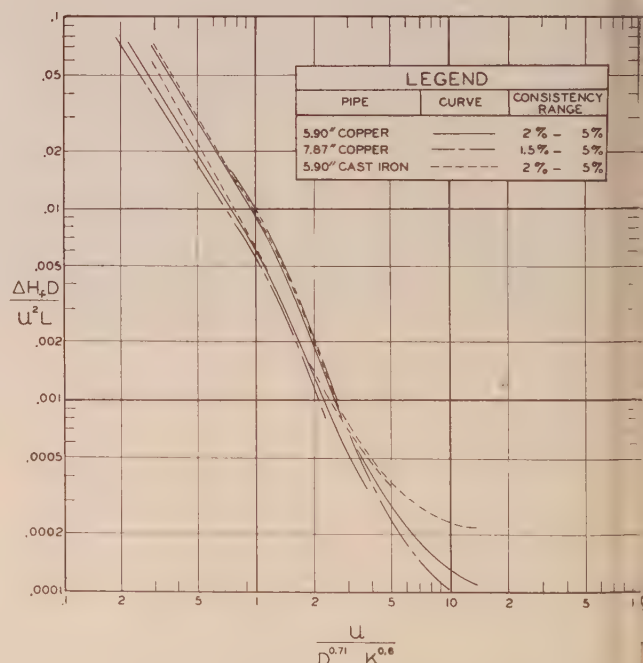

Fig. 2. Correlation of Brecht and Heller data in which K equals the value in feet at the first maximum in the friction loss curve

sulting group is not amenable to dimensional analysis. Rather it is an empirical relationship which has practical application. We have given the group, $Du\rho/C$, the name, pseudo-Reynolds number, (Re′ number) since it serves the same purpose in our correlation as the classical Reynolds number serves in the analysis of Newtonian flow systems.

The problem of the correlation of any set of consistent data on head loss became simple once the concept of the pseudo-Reynolds number was developed. For any experimental values of head loss in feet of water per 100 ft. of pipe, flow velocity in feet second, pulp consistency, and pipe diameter it was possible to calculate $\Delta H_f D/u^2 L = f$ and plot on fully logarithmic paper as the ordinate, with the corresponding Re′ number as the abscissa. The analysis of the Brecht and Heller data for unbleached sulphite pulp disclosed that for any given consistency and pipe diameter a series of points was obtained defining a nearly straight line on the log-log plot. For each consistency and pipe size another nearly parallel line was defined (Fig. 3). The correlation became more valuable when exponential terms were applied to the diameter and consistency terms. The Re′ number thus became $D^m u\rho/C^n$.

The consistency exponent was determined first, by plotting the Re′ number versus consistency at a constant value of the friction factor (Fig. 3). The relationship of Re′ number versus C was plotted on log-log paper at three friction factor values and lines drawn through the points. The average slope of the lines was determined to be 0.157 Multiplying the unexponential Re′ number by $1/C^{0.157}$ gave $Du\rho/C^{1.157}$. The data were again calculated plotting the friction factor versus

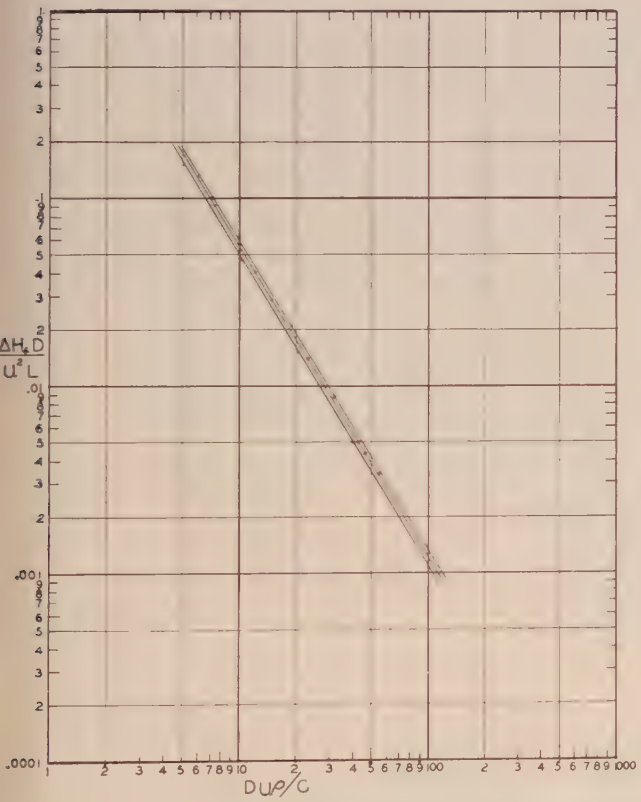

Fig. 3. Step one in derivation of pseudo-Reynolds number based on Brecht and Heller data

the new Re′ number. This gave a plot of two nearly straight parallel lines, one for each pipe diameter (Fig. 4). Using the same technique as that employed in finding the exponent for the consistency the slope was found to be 0.795. Multiplying $Du\rho/C^{1.157}$ by $1/D^{0.795}$ gave the final Re′ number, $D^{0.205}u\rho/C^{1.157}$, for the Brecht and Heller data.

The data for unbleached sulphite pulp presented by Brecht and Heller for all consistencies and two pipe diameters were replotted using the above Re′ number. All the points for velocities up to about 10 ft. per sec. were found to fall in a narrow band on the log-log plot

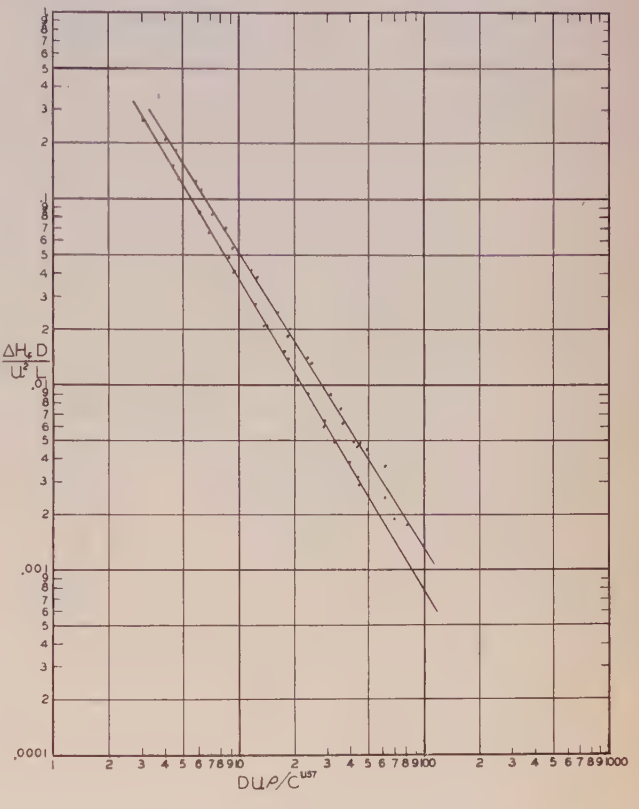

Fig. 4. Step two in derivation of pseudo-Reynolds number based on the Brecht and Heller data

easily represented by a single straight line, relating friction factor to the Re′ number (Fig. 5). This curve makes possible the prediction of the head loss due to pipe friction, when pumping sulphite stock, with an accuracy of ±7% for all consistencies and for velocities below a value in feet per second equal to the consistency in per cent raised to the 1.2 power.

The Forrest and Grierson Correlation

The correlation developed for the Brecht and Heller data was applied to the head loss curves of the Forrest and Grierson data (*3*). The data did not reduce to the narrow band displayed by the Brecht and Heller data (Fig. 6). In order to obtain a more concise grouping of the points the original data were subjected to the same mathematical analysis as the Brecht and Heller data. New exponents were obtained and the Re′ number for the Forrest and Grierson data for sulphite pulp became $u\rho/D^{0.4}C^{1.87}$, while for groundwood the Re′ number had the terms and exponents, $D^{0.15}u\rho/C^{1.385}$. Using these relationships the data presented a very close banding of the points through which a single straight line could be drawn, as shown, in the case of sulphite pulp, by Fig. 7. Each of these relationships holds within ±25% for all pipe diameters, consistencies, and velocities presented in the data.

The Cameron Correlation

The mathematical analysis was repeated using the Cameron (*4*) data for groundwood. The Re′ number for this set of data had the form, $D^{0.01}u\rho/C^{2.25}$. In this case the correlation did not result in the close banding of the points that was obtained in the previous sets of data (Fig. 8).. The relationship is good within ±30% exclusive of consistencies below 1.8% moisture-free stock. For these low consistencies the correlation deviated progressively upward to +100% as the consistency decreased to 1.5%, the velocity increased from 4 to 16 ft. per sec., and the pipe diameter increased from 6 to 16 in.

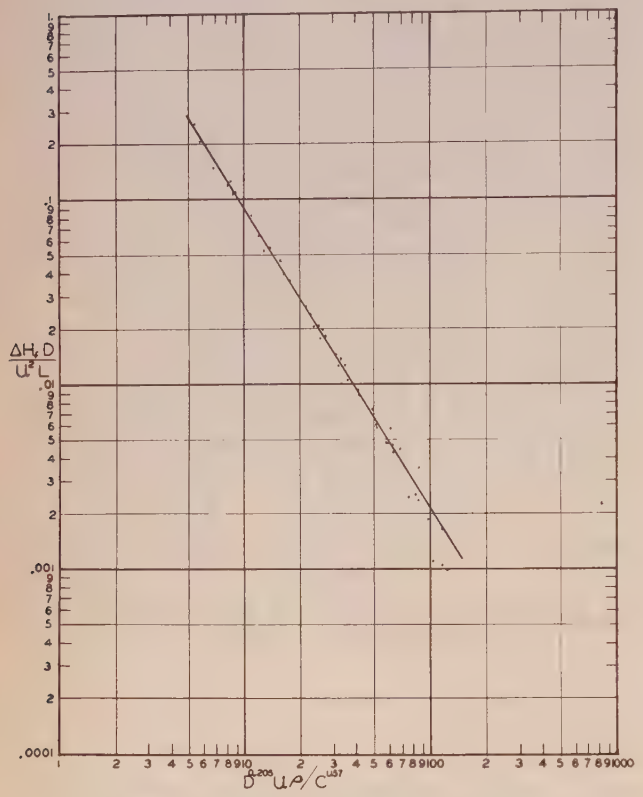

Fig. 5. Correlation of Brecht and Heller data by use of pseudo-Reynolds number

The derivation of the correlation for each set of friction loss data that has been reported could have been computed. It was believed, rather, that a single correlation should be established as the standard. The correlation based on the Brecht and Heller data was selected as that standard since that body of data showed the highest order of consistency within itself, indicated by the fact that the data points showed the least scattering. The correlation represented by the plot of Fig. 5 is the graphical expression of the equation

$$\frac{\Delta H_f D}{u^2 L} = f = \phi\left(\frac{D^{0.2}u\rho}{C^{1.16}}\right) \qquad (1)$$

Table I. Range of Application, Friction Factor Plot, Fig. 9, with Degrees of Accuracy Expected

Data group	*Re′ number range*	*Deviation, %*
Brecht and Heller, unbleached sulphite	8– 80	± 7
Forrest and Grierson, sulphite	6–120	±25
Forrest and Grierson, groundwood	10–150	±25
Cameron, groundwood	20–200	±50

The family of curves in Fig. 9 resulted from correlating the data of Brecht and Heller for unbleached sulphite pulp, the Forrest and Grierson sulphite and groundwood data, and the Cameron groundwood data using the Brecht and Heller Re′ no. $D^{0.2}u\rho/C^{1.16}$ as the abscissa on the friction factor plot. The accuracy is indicated by the data in Table I.

The Independent Variables, Stock, Temperature, Freeness, and Pipe Roughness

The Brecht and Heller data present some limited results of their work on stocks other than unbleached

Table II. Effect of Stock on Head Loss, Variation from Calculated Head Loss for Unbleached Sulphite

Stock	*Re′ number range*	*Correction factor*	*Expected deviation, %*
Unbleached sulphite	8– 80	1.00	± 7
Bleached sulphite	16– 64	0.88	+ 5
Unbleached straw	16– 40	0.45	±11
Bleached straw	16– 40	0.90	± 1
Groundwood	16– 64	1.42	± 6
Cooked groundwood	16– 64	1.00	± 6
Sulphate	16–100	0.90	±15

sulphite. Using the small amount of data presented the effect of stock upon the head loss has been analyzed and correction factors computed to correct the calcu-

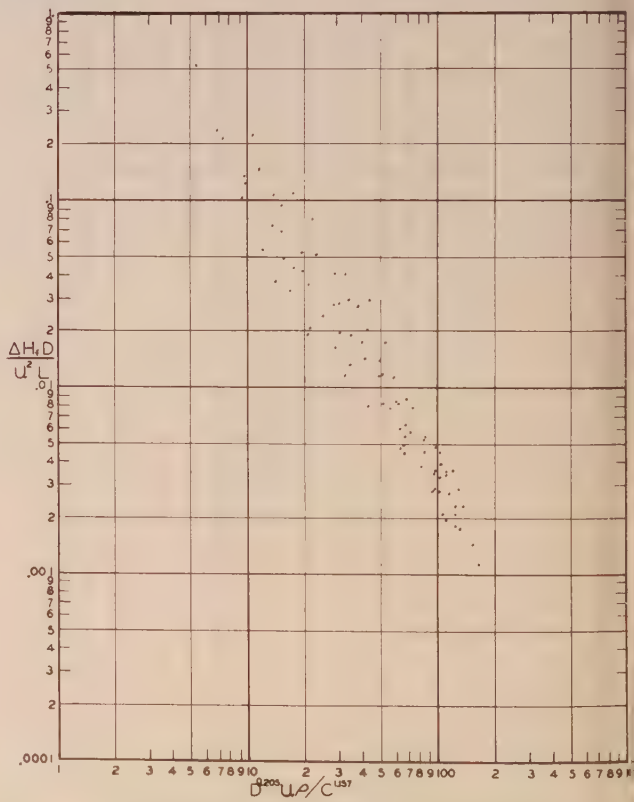

Fig. 6. Correlation of Forrest and Grierson data for unbleached sulphite pulp using the Re′ no. $D^{0.205}\ u\rho/C^{1.157}$

lated head loss for unbleached sulphite to the head lo for other stocks. The deviation which may be expecte in the results has also been computed and the resul compiled in Table II.

The temperature coefficient in the computation head loss appears small from the data of Brecht a

Heller. Their data on stocks for both 4 and 5% consistency flowing through pipes of 5.90 and 7.87 in. in diameter showed that the average change in head loss with temperature was about ½ of 1% for each degree of temperature change. The range of temperatures studied was from 18 to 36°C. For both consistencies and both pipe diameters the friction factor was found to decrease as the temperature increased.

The data relating freeness to head loss were limited to some studies by Brecht and Heller (*1*) and Nilson (*10*). The former reported on unbleached sulphite in which the S.-R. freeness ranged from 210 to 820, and unbleached and bleached sulphate stock of freeness ranging from 190 to 860. Nilson presented data on unbleached sulphate only, over the range of freeness from 384 to 830. For the unbleached sulphite stock the variation of the friction factor was nearly uniform for any Re′ number increasing as the freeness value decreased. The sulphate stock, both unbleached and bleached, showed varying effect of head loss with changes in freeness. At low Re′ number the head loss increased with decreasing freeness, but as the Re′ number increased, that is at higher velocities for a given pipe size and pulp consistency, the head loss variation with freeness decreased to zero. With further increases of the Re′ number the head loss varied directly with the freeness. The findings of Brecht and

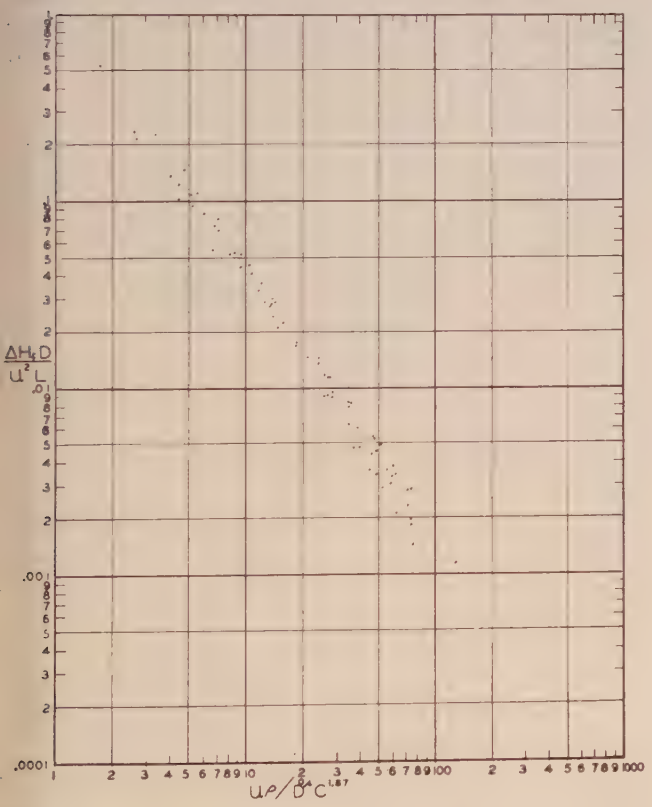

Fig. 7. Correlation of Forrest and Grierson data for unbleached sulphite pulp using a pseudo-Reynolds number derived from its own data

Heller were substantiated by Nilson's work using unbleached sulphate stock. The data, which were available, were so limited that it was not possible to incorporate a freeness factor in the correlation.

Pipe roughness is a factor in the head loss which is well known. However, data showing the relationship are very limited. Brecht and Heller presented some data for a single pipe size and one consistency, which showed that for low Re′ number, around 10, the friction factor was the same for both copper and cast iron pipe. As the Re′ number increased with increasing velocity the friction factor for cast iron pipe fell below that for

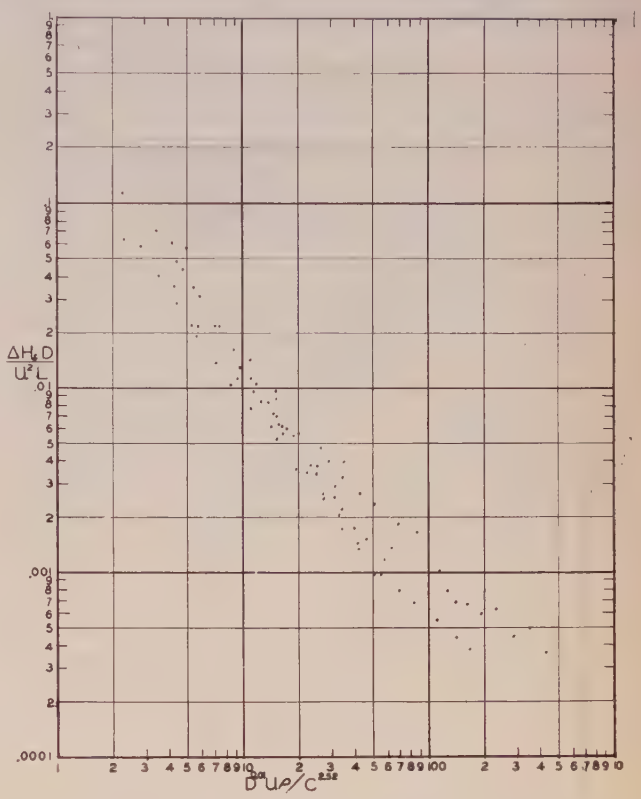

Fig. 8. Correlation of Cameron data for groundwood pulp using a Pseudo-Reynolds number derived from its own data

copper pipe until at Re′ number of 100 the factor for cast iron was about 84% of that for copper pipe.

APPLICATION OF THE PROPOSED CORRELATION

The calculation of the head loss which may be expected in a pipe-line transporting pulp stock requires only the substitution of the values for the variables, pipe diameter expressed in feet, flow velocity in feet per second, and pulp consistency in per cent moisture-free stock in the Re′ number expression. The numerical value of the Re′ number fixes the friction factor f. The relationship $\Delta H_f D/u^2 L = f$, solved for ΔH_f gives the frictional head loss in feet of water per 100 ft. of straight pipe.

Illustrative example: What head loss will result when a 4% consistency unbleached sulphite stock is pumped through 100 ft. of 8-in. pipe at a velocity of 5 ft. per sec.?

Solution:

$$\text{Re′ no.} = \frac{\left(\frac{8}{12}\right)^{0.2} \times 5 \times 62.4}{4^{1.16}} = 58$$

f, at Re′ no. of 58 = 0.0052 (plot Fig. 9)

$$\Delta H_f = \frac{0.0052 \times 5^2 \times 100}{0.666} = 20 \text{ ft.}$$

The Brecht and Heller curves show 21.8 ft.

If we wished to use the Forrest and Grierson data the friction factor would be 0.0085 instead of 0.0052 (read from the Forrest and Grierson curve on Fig. 9) and

$$\Delta H_f = \frac{0.0085 \times 5^2 \times 100}{0.666} = 32 \text{ ft.}$$

The observed head loss shown by the Forrest and Grierson curves would be 43 ft., the calculated value being 25.5% low.

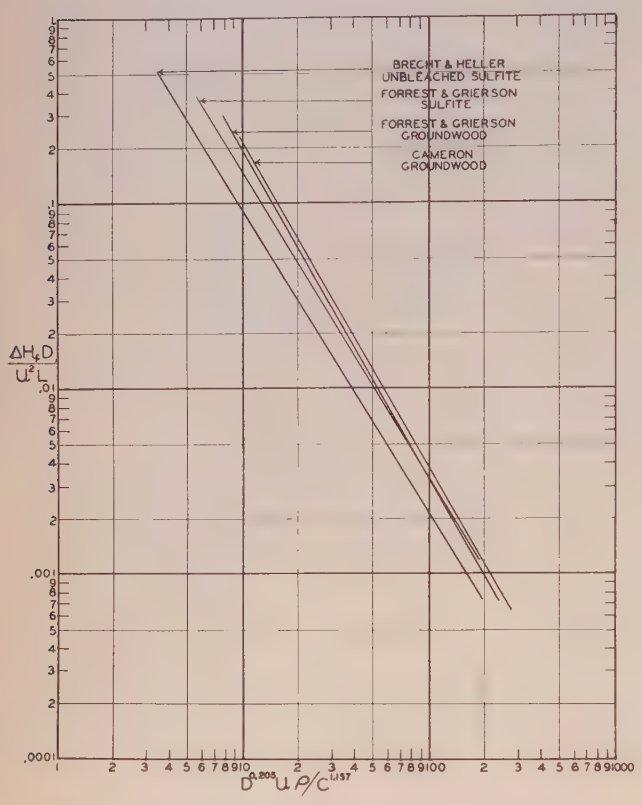
BRECHT & HELLER UNBLEACHED SULFITE
FORREST & GRIERSON SULFITE
FORREST & GRIERSON GROUNDWOOD
CAMERON GROUNDWOOD
ΔH_f D / U² L
D^0.205 U ρ / C^1.157

Fig. 9. Plot of the friction factor "f" vs. the Re′ no. "$D^{0.205}\ U\rho/C^{1.157}$" for the data indicated

If instead of unbleached sulphite we wished to predict the head loss for groundwood of the same consistency we would correct the calculated value by the factor 1.42 (Table II). The Cameron curves for groundwood show, by interpolation, the head loss would be about 37 ft., whereas the calculated value would be 28.4 ft.

The correlation based on the Brecht and Heller data lends itself nicely to solution by means of two nomographs. The first evaluates the Re′ number when the pipe diameter, velocity, and stock consistency are known. The second nomograph is entered using the friction factor read corresponding to the Re′ number previously determined. By properly joining the friction factor with the velocity, noting the intersection of the joining line with the reference line, and finally joining this point with the diameter scale the head loss is obtained with an accuracy of 95% or higher, compared with the result obtained by detailed calculation.

DISCUSSION OF RESULTS

The correlation of any considerable body of data incorporates into the correlation the inexactnesses within the data itself. There is no basis for questioning the accuracy of any of the data used in this study. The differences which exist in the numerical values of head loss are believed to be due to variations in the physical arrangement of the test equipment use in obtaining the data.

The correlation based on the Brecht and Heller data was made the basis for the over-all correlation since it plotted all the various data more closely than any other single correlation.

The Forrest and Grierson, and the Cameron data plotted on the Brecht and Heller coordinates, show very definite trends When a standard deviation of ± 25% was applied to the Cameron data points it was found that 55% of all points fell outside the deviation zone. The points to the left of the zone represented head loss curves for low consistency stocks flowing at low velocities. The most widely scattered points here represented the largest pipe sizes and the lowest velocities for any given consistency. Conversely, the scattered points to the right of the deviation zone represented high consistency stocks, and high velocities Also the most widely scattered points represented the smallest pipe sizes and highest velocities for any given consistency. In general it may be stated that the points of wide deviation represent conditions which are generally practiced in the transportation of pulp suspensions.

In a similar manner the Forrest and Grierson data for unbleached sulphite stock showed 40% of the points falling outside a ±25% deviation zone. The same combination of conditions as those given above applied

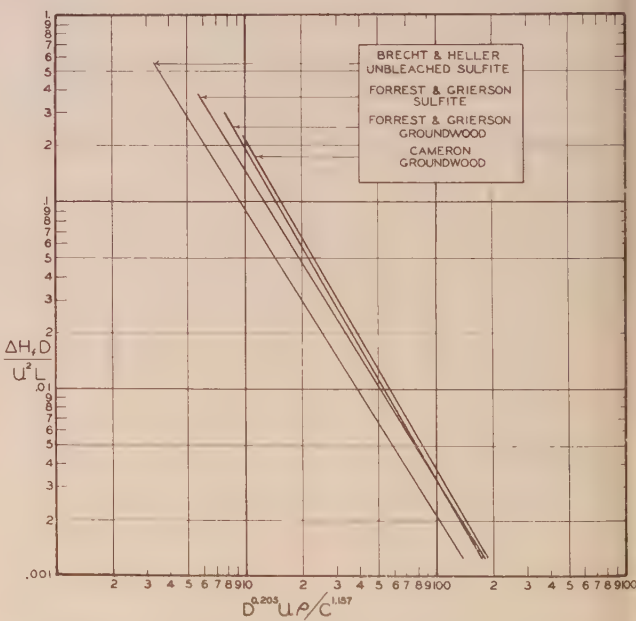
BRECHT & HELLER UNBLEACHED SULFITE
FORREST & GRIERSON SULFITE
FORREST & GRIERSON GROUNDWOOD
CAMERON GROUNDWOOD
ΔH_f D / U² L
D^0.205 U ρ / C^1.157

Fig. 10. Friction factor plot for pulp suspensions

to the most widely scattered points; that is, points representing low consistency stocks flowing in large pipes at low velocities were again to the left of the zone while those representing high consistency stocks flowing in small pipes at high velocities were to the right of the zone.

The Forrest and Grierson data for groundwood were more closely grouped than either the Cameron ground

wood or the Forrest and Grierson sulphite. Only 22% of the data points fell outside the ±25% deviation zone. The scattered points showed the same pattern of conditions as did the previously discussed data.

The correlation of the stock flow data that has been proposed as a method of computation of frictional head loss could not justifiably be used outside the range of conditions covered by the data from which it was derived. It likewise would yield the best results when coupled with the experience of seasoned hydraulic engineers.

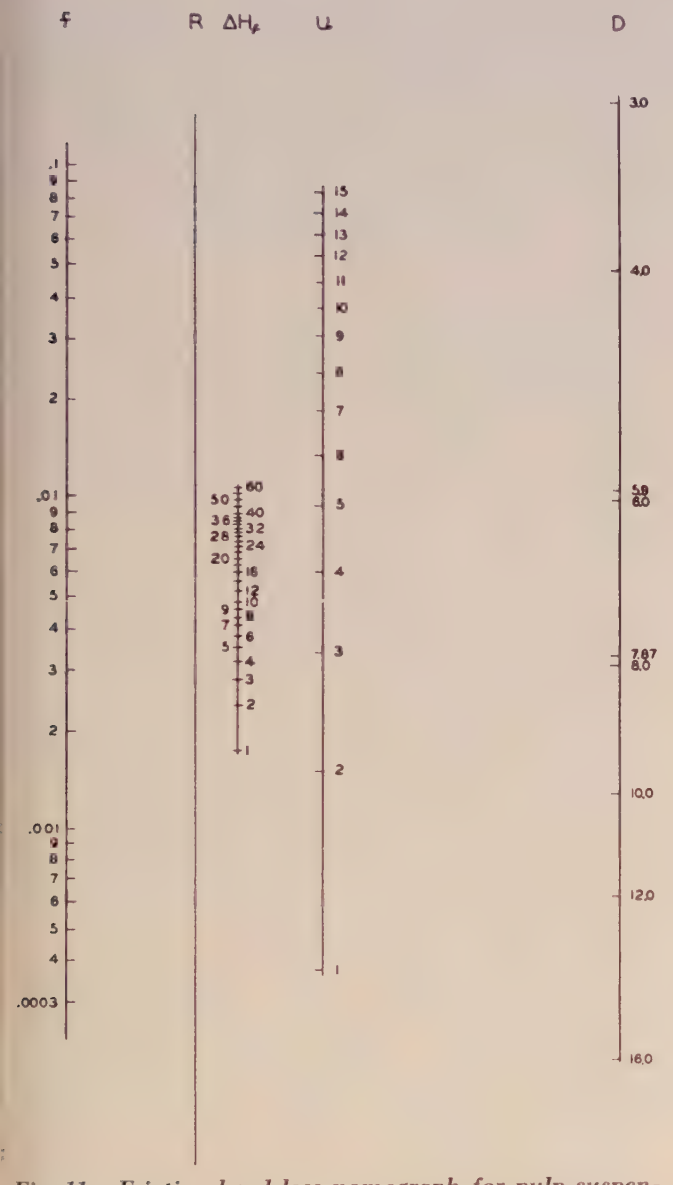

Fig. 11. Friction head loss nomograph for pulp suspensions flowing in pipes based on Brecht and Heller data

The proposed correlation is suggested for the computation of frictional head loss in transporting high consistency stocks. While these consistencies have not been included in the data studied, inspection of the Re′ number for such stocks flowing in large pipes shows them to be small, 25 or less, and in the upper region of the friction factor plot. In this region all the data analyzed showed less scattering than in any other section of the plot. The authors will be extremely interested in obtaining data on the frictional loss for such stocks to check against the correlation.

CONCLUSIONS

An analysis has been made of various data on the frictional head loss encountered in pumping pulp stocks through pipes. Based on this analysis, a correlation of data has been proposed which relates a friction factor to a pseudo-Reynolds number by the expression

$$\frac{\Delta H_f D}{u^2 L} = f = \phi\left(\frac{D^{0.2} u \rho}{C^{1.16}}\right)$$

in which the consistency term has replaced the conventional viscosity term.

The proposed correlation can be used for the computation of frictional head loss of various pulp suspensions flowing in pipes. The range of application covers the conditions of consistency, velocity, and pipe size generally practiced in the industry

The correlation is presented for the purpose of establishing a standard basis for computing the frictional head loss for pulp suspensions. It incorporates the differences found in the data studied. It is not presented as a completed work but rather as a background upon which a more exact method can be established when data are available which will make possible such a correlation including additional variables such as, for example, stock freeness and temperature.

ACKNOWLEDGMENT

The authors wish to acknowledge the interest and guidance of the Hydraulics Committee of TAPPI, and the financial assistance from that organization which made the project possible. To those investigators whose data were used in the study, in particular Dr. Brecht for the Brecht and Heller data, Frank Forrest for the Forrest and Grierson data, and the Ingersoll-Rand Co. for the Cameron data, special acknowledgment is made. To Roger Stinchfield whose correlation materially aided the work and to Clayton Burnell on whom fell the major amount of the routine analysis our thanks are especially expressed.

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Products from the Destructive Distillation of Douglas-Fir Lignin

T. L. FLETCHER and ELWIN E. HARRIS

Lignin obtained as a residue in the hydrolysis of Douglas-fir sawmill waste was pyrrolyzed at 400 to 445°C. in about 7.5 hr., yielding 53 to 64.6% of char, 15 to 25% of aqueous distillate, a settled tar, and gases. Settled and dissolved tar was removed from the aqueous distillate and separated into organic acids, phenolic compounds, and neutral oils. Nine organic acids and 11 phenolic compounds were fractionated and identified. Pyrrolysis of wood-saccharification lignin offers a means for producing high yields of char which can be briquetted or activated. It also provides a source of organic acids and phenolic compounds with potential value in plastics or organic intermediates.

A LIGNIN residue remains when the carbohydrate portion of wood is hydrolyzed to sugar. Since there is no profitable large-scale use for this residue it is essentially a waste product. To obtain information that might indicate some means for utilizing lignin from wood saccharification, the lignin residue from the acid hydrolysis of Douglas-fir sawmill waste was dried and subjected to destructive distillation at atmospheric pressure. A high yield of char, an aqueous distillate, and a settled tar were produced. Analyses of the distillation products are presented in this report.

In addition to this work at the Forest Products Laboratory, several other investigators have distilled lignin and studied the products. The most significant work was that of Bridger (*1*) who distilled alkali lignin from corncobs.

PROCEDURE AND MATERIALS

External heating of a retort packed with dry lignin at 430° C., the first distillation procedure tried, produced poor heat transfer through the lignin which was a fine powder. After 13 hr., the temperature of the lignin in the interior was raised to only 180°C.

Three methods were tried to obtain better heat transfer. In one method, the lignin was made into pellets or small briquettes in which form it was easily carbonized. In the second method, mechanical pressure was applied to the lignin during the carbonization. This method gave satisfactory distillation and also a dense charcoal. In the third method, copper tubes were welded lengthwise in the basket in which the lignin was placed in the retort, and the lignin was packed around the tubes. Heat penetrated throughout the lignin by means of the tubes, and a uniform distillation resulted. The third method of distillation was used to produce the data in this report.

Lignin residues containing 13 to 38% of cellulose were destructively distilled. Some of the lignin samples were washed with water. Others were unwashed and contained 1 to 2% of sulphuric acid. Table I gives the results of the distillation. The yield of char decreased with increase in cellulose content and was less with washed samples than with unwashed samples. Distillation was at a uniform rate and produced a distillate consisting of an aqueous layer, a settled tar, and noncondensable gases.

EXAMINATION OF PRODUCTS

Char

Analysis of the char from the various runs showed it to be a uniform product. Unwashed samples gave a char containing 0.05% of sulphur, compared to 0.02% of sulphur in the char from washed samples. Other values for the char were: volatile products, 12.7 to 13.5%; fixed carbon, 83.7 to 84.8%; and ash, 0.2 to 0.7%. The char was a fine powder.

Aqueous Layer

Preliminary analysis of the aqueous distillate by conventional methods for the analysis of wood distillates showed the presence of 0.3 to 0.5% of methanol, 0.15 to 0.25% of acetone, 0.14% of formic acid, and 0.2 to 0.4% of acetic acid, based on the weight of the dry lignin. Preliminary treatment of the settled tar showed the presence of phenol, *o*- and *p*-cresol, guaiacol, 2,4-xylenol, and substituted guaiacols (*4*).

Since several products were distributed between the aqueous layer and the settled tar, the aqueous layer was separated into its constituents, as shown in Fig. 1. The total settled tar plus the tar from the aqueous layer amounted to 9% of the lignin.

Heavy Settled Tar

Low-boiling products were removed by distillation from the heavy tar. These products were dissolved in neutral ethyl acetate and were separated by sodium bicarbonate into an acid fraction and a neutral fraction. The two fractions were added to similar products from the aqueous layer.

Preliminary tests to fractionate the high-boiling tar indicated a tendency to decompose. It was thought that decomposition might be catalyzed by the presence of bituminous compounds. To remove such compounds, the tar was extracted in a continuous liquid extractor with low-boiling petroleum ether. Only a small residue of insoluble material remained.

When the petroleum-ether solution was cooled, a product crystallized from it. Refrigeration brought down another crop of crystals. The crystals were removed by filtering and, on recrystallization, were shown to be a mixture of fatty acids and waxes found pre-

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Table I. Results of Destructive Distillation of Douglas-Fir Hydrolysis Residues

Run No.	Charge, dry weight, lb.	Cellulose content of sample, %	Acid content of sample, %	Maximum temperature of distillation, °C.	Time of distillation, hr.	Yield				
						Aqueous distillate plus tar[a]		Char		Loss,[b] %
						Lb.	%	Lb.	%	
2	39.6	13.6	1.29	400	9	8.3	21.2	25.6	64.6	14.2
3	35.56	18.4	1.29	420	7.5	8.34	23.5	22.6	63.9	12.8
4	31.5[c]	20.8	0	410	7.5	7.95	25.2	18.6	59.0	15.8
5	36.1[c]	34.2	0	400	7.2	9.56	26.5	20.4	56.6	16.9
6	31.6	20.0	1.29	445	7.5	6.66	22.2	19.2	63.8	14.0
7	27.1[c]	38.0	0	435	7.5	8.24	30.4	14.5	53.3	16.3

[a] Aqueous distillate corrected for moisture in sample.
[b] Gases and mechanical loss.
[c] Sample was washed with water to remove acid.

viously in the bark and lignin residues of Douglas-fir (*3*). Addition of the filtrate, or petroleum-ether solution of tar, to an excess of cold methanol precipitated more crystals. These crystals were collected, washed with cold methanol, and recrystallized from a mixture of petroleum ether and methanol. The product was a white crystalline wax melting at about 70°C. It represented 5.5% of the heavy tar, or 0.5% of the original lignin. The Douglas-fir lignin prior to distillation contained 4.6% of the wax.

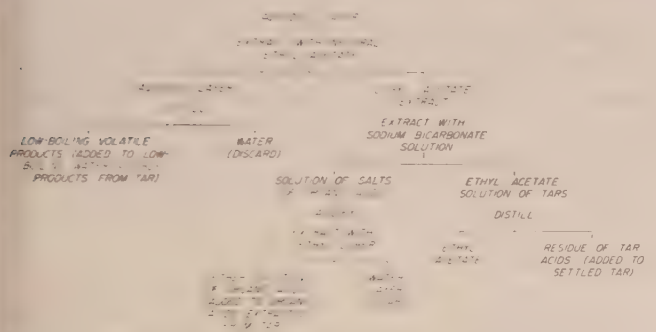
EXTRACT WITH SODIUM BICARBONATE SOLUTION
WATER (DISCARD)
SOLUTION OF SALTS
ETHYL ACETATE SOLUTION OF TARS
DISTILL
RESIDUE OF TAR ACIDS (ADDED TO SETTLED TAR)

Fig. 1. Separation of constituents of the aqueous layer from the pyrrolysis of Douglas-fir lignin residue

After removal of the wax, organic acids and other water-soluble products were removed from the solution of the tar by countercurrent extraction with a 5% solution of sodium bicarbonate. Methanol and other low-boiling products were removed from the sodium bicarbonate extract by fractional distillation, and the residue containing organic acids was combined with the acid fraction from the aqueous layer.

The residual tar from the extraction of organic acids was diluted with an equal volume of petroleum ether and extracted three times with a 50% solution of sodium hydroxide mixed with 2 volumes of methanol (*5*) to remove phenols. Petroleum ether was used to remove neutral oils dissolved by the alcoholic sodium hydroxide solution. Sixty per cent of the residual tar was alkali soluble, representing 5.4% of the lignin. When a sample of the tar was extracted with a 10% solution of alkali, only 35.5% of the tar dissolved in the alkali.

The alkaline solutions of phenols from the three extractions were combined and acidified, and the phenols were separated from the water layer. The mixture of phenols was steam distilled to remove the steam-volatile phenols. About 60% of the mixture was volatile and designated as steam-volatile phenols.

The residue from the steam distillation was diluted with petroleum ether and extracted several times with a saturated borax solution to remove the polyhydroxy phenols, according to the method of Burke and Caplan (*2*). Twenty-five per cent of the nonsteam-volatile phenol mixture was extracted by the borax solution. The borax solution was acidified, and the phenolic substances were taken up in ethyl ether and dried over anhydrous sodium sulphate. The products were designated as catechols.

When the petroleum ether was removed from the oils left after removal of the polyhydroxy phenols, a viscous, dark-brown oil was obtained. This oil residue showed only a trace of catechols when tested with lead acetate. It was designated as nonsteam-volatile phenols.

A flow diagram of the fractionation of the settled tar is shown in Fig. 2.

EXPERIMENTAL PART

The various fractions were subjected to fractional distillation as follows:

Low-Boiling, Water-Soluble Neutral Compounds

The low-boiling, water-soluble products from the settled tar and the aqueous layer were combined and fractionated. Fraction I, representing about 0.7% of the lignin, boiled at 45 to 60°C. and was identified as acetone. Fraction II, representing about 1% of the lignin, boiled at 60 to 70°C. and was identified as methanol. Higher-boiling fractions, representing about 1% of the lignin, contained methylethylketone and unidentified products.

Table II. Organic Acids Obtained from the Pyrrolysis of Douglas-Fir Lignin

Product	Distilling range, °C.	Yield from fraction, %	Characterized as	Melting point of derivative, °C.
Formic acid	100–101	20	*p*-Bromphenacyl ester	140
Acetic acid	110–120	30	*p*-Bromphenacyl ester	84.5–85.5
Propionic acid	76–81 at 50 mm.	10	*p*-Bromphenacyl ester	63.0–63.5
n-Butyric acid	89–94 at 50 mm.	..	*p*-Bromphenacyl ester	62.5–64.0
n-Valeric acid	110–111 at 50 mm.	..	*p*-Bromphenacyl ester	72–73
n-Caproic acid	124–128 at 50 mm.	..	*p*-Bromphenacyl ester *n*-Caproamide	68–70 99.5–100.0
n-Enanthic acid	141–142 at 50 mm.	..	*p*-Bromphenacyl ester	69–70
n-Caprylic acid	133–134 at 20 mm.	..	*p*-Bromphenacyl ester	65–66
Benzoic acid	135–136 at 10 mm.	..	Benzoic acid	121.5–122.5

Table III. Steam-Volatile Phenols Obtained from Pyrrolysis of Douglas-Fir Lignin (3.2% of the Lignin)

Product	Distilling range °C.	Yield from fraction, %	Characterized as	Melting point of derivative, °C.
Phenol	61 at 6 mm.	9	Aryloxy acetate	97–99
o-Cresol	66–70 at 5 to 6 mm.	4	Aryloxy acetate	151–153
p-Cresol	77–78 at 5 to 6 mm.	1	Aryloxy acetate	136.0–138.5
Guaiacol	78–80 at 5 to 6 mm.	27	Aryloxy acetate	115–117
			3,5-Dinitrobenzoate	139.5–140.0
2,4-Xylenol	82–86 at 5 to 6 mm.	6	Aryloxy acetate	140.0–141.5
4-Methylguaiacol	86–87 at 6 mm.	28	Aryloxy acetate	117–118
			3,5-Dinitrobenzoate	92.0–92.5
4-Ethylguaiacol	97–98 at 6 mm.	13	3,5-Dinitrobenzoate	122–123
4-*n*-Propylguaiacol	100 at 4 mm.	2.6	3,5-Dinitrobenzoate	114.5–116.0
Residue and losses	.....	9.4	.....	.....

Organic Acids

Sodium bicarbonate solutions of organic acids extracted from the aqueous layer and from the settled tar were combined and evaporated to about one-fourth of the original volume in a tubular glass evaporator, acidified, and extracted with ether. The total acid represented about 1% of the weight of the lignin, of which

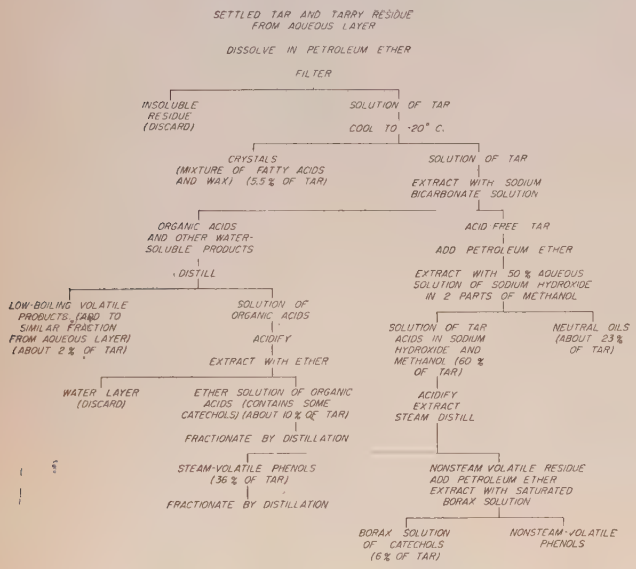
SETTLED TAR AND TARRY RESIDUE FROM AQUEOUS LAYER
DISSOLVE IN PETROLEUM ETHER
FILTER
INSOLUBLE RESIDUE (DISCARD)
SOLUTION OF TAR
COOL TO -20° C.
CRYSTALS (MIXTURE OF FATTY ACIDS AND WAX) (5.5% OF TAR)
SOLUTION OF TAR
EXTRACT WITH SODIUM BICARBONATE SOLUTION
ORGANIC ACIDS AND OTHER WATER-SOLUBLE PRODUCTS
ACID FREE TAR
DISTILL
ADD PETROLEUM ETHER
EXTRACT WITH 50% AQUEOUS SOLUTION OF SODIUM HYDROXIDE IN 2 PARTS OF METHANOL
LOW-BOILING VOLATILE PRODUCTS (ADD TO SIMILAR FRACTION FROM AQUEOUS LAYER) (ABOUT 2% OF TAR)
SOLUTION OF ORGANIC ACIDS
SOLUTION OF TAR ACIDS IN SODIUM HYDROXIDE AND METHANOL (60% OF TAR)
NEUTRAL OILS (ABOUT 23% OF TAR)
ACIDIFY
EXTRACT WITH ETHER
WATER LAYER (DISCARD)
ETHER SOLUTION OF ORGANIC ACIDS (CONTAINS SOME CATECHOLS) (ABOUT 10% OF TAR)
ACIDIFY
EXTRACT
STEAM DISTILL
FRACTIONATE BY DISTILLATION
STEAM-VOLATILE PHENOLS (36% OF TAR)
NONSTEAM VOLATILE RESIDUE
ADD PETROLEUM ETHER
EXTRACT WITH SATURATED BORAX SOLUTION
FRACTIONATE BY DISTILLATION
BORAX SOLUTION OF CATECHOLS (6% OF TAR)
NONSTEAM-VOLATILE PHENOLS

Fig. 2. Fractionation of settled tar

amount about 60% was contained in the settled tar. The mixture of acids was fractionated by distillation, and the products shown in Table II were identified.

Steam-Volatile Phenols

Steam-volatile phenols, representing 36% of the total tar, or 3.2% of the lignin, were separated by fractional distillation. Eight products were identified, as shown in Table III.

Catechols

Phenolic substances, representing 10% of the total phenolic substances in the settled tar, were extracted from the nonsteam-volatile phenols by a saturated borax solution. Some catechols were present with the organic acids extracted from the tar by sodium bicarbonate. The phenolic substances extracted from the nonsteam-volatile phenols were taken up in ether and dried with anhydrous sodium sulphate. The dried ether solution was subjected to fractional distillation, as shown in Table IV.

About 40% of the substances remained as a high-boiling tar that decomposed on further heating.

Nonsteam-Volatile Phenols

After steam distillation of the phenolic fraction and extraction of the nonsteam-volatile residue with sodium borate, about 30% of the phenols remained as high-boiling products. Attempts at distillation indicated no identifiable products; attempts to produce solid derivatives were unsuccessful.

Neutral Oils

About 23% of the total tar was insoluble in alcoholic sodium hydroxide solution. These neutral oils contained hydrocarbons, hydroxy compounds, and compounds that reacted with 2,4-dinitrophenyl hydrazine, but no products were identified.

CONCLUSIONS

The high yield of char with a low ash content resulting from the destructive distillation of lignin promises a use for the lignin resulting from wood saccharification. This char can be briquetted or pressed in various shapes for uses requiring large pieces or activated for use as a purifying agent.

Forty to fifty per cent of the lignin is converted during the pyrrolysis to volatile products consisting of gas, water, and organic products. The gas and water represent ultimate decomposition products. The various distillable organic products have potential value for plastics or organic intermediates. A study of these products may produce information leading to their utilization and indirectly throw some light on the structure of lignin.

The production of methanol in the distillation of lignin is low, compared with the methoxyl content, and

Table IV. Catechols in the Tar Obtained from Pyrrolysis of Douglas-Fir Lignin

Product	Distilling range, °C.	Characterized as	Melting point of derivative, °C.
Catechol (50% of fraction)	131–135 at 15 mm.	Catechol	102.5–104.0
		Diacetate	61.5–63.0
4-Methylcatechol	140–150 at 15 mm.	3,5-Dinitrobenzoate	170
4-Ethylcatechol	152–155 at 15 mm.	Carbanilate	157–159
4-*n*-Propylcatechol	160–163	3,5-Dinitrobenzoate	78–80

probably consists of methanol that survives the pyrrolysis. The methoxyl content not isolated as methanol or methoxy derivatives was assumed to be converted to gas and may account for most of the methane in the gas produced in the pyrrolysis of lignin.

Water results from the cleavage of oxygen in hydroxy and methoxy groups.

The organic acids produced in the pyrrolysis of lignin result from the rearrangement and cleavage of the lignin molecule. The low yield of acetic acid, as compared to that obtained from destructive distillation of wood, indicates that the acetyl groups of hemicellulose are the source of the acetic acid in wood distillation.

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Diaphragm Error and Testing Rate in the Paper Bursting Test

F. T. CARSON and VERNON WORTHINGTON

The diaphragm error can be virtually eliminated by (1) selecting rubber diaphragm material no thicker than is necessary for the range of papers to be tested, (2) bringing the diaphragm as close as practicable to the paper, and (3) installing it with adequate slack. A method of evaluating the diaphragm error is described: the space between diaphragm and paper is filled with liquid, a very thin film of rubber is laid over the liquid and sealed with grease under the edges. Tests with this arrangement in comparison with normal tests afford a good indication of the diaphragm error. To determine the rate of stressing the paper, the gross rate of displacing liquid must be supplemented by an "apparatus constant," evaluated in terms of the volume of liquid displaced in the apparatus, exclusive of the volume of the paper dome, through the middle half of the pressure range of the gage used. A height gage, useful in routine assessment of the diaphragm installation, and an air trap, useful in deairing gages, are described and illustrated.

The long-standing popularity of the bursting test must be ascribed to the ability of the test to evaluate in one simple operation a composite of strength, stretch, flexure, and toughness. This composite value correlates well in experience with many uses of paper that combine these characteristics in a complex manner difficult to evaluate otherwise. The test is arbitrary in nature, and the measurement is a good example of a property defined by the method of measurement. The principle involved is very simple. Paper is clamped between two concentric annuli; hydraulic pressure is applied so that the paper expands domewise through the orifice in one annulus until it bursts. A maximum-reading pressure gage shows the bursting pressure. In addition to the strength of the paper, the bursting pressure depends on a number of design factors, such as the size of the bursting orifice, the effectiveness of clamping, and the manner and rate of applying the hydraulic pressure.

Some years ago the Bureau made a study of some of the factors that influence the bursting-strength test (*1, 2*). More recently Tuck and Mason (*3*) have reported on factors that influence the rate of testing and the behavior of gages. The investigation reported herein has been concerned chiefly with reducing the error associated with the diaphragm and with working out practical, unequivocal means of fixing the rate of testing.

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THE DIAPHRAGM ERROR

In the bursting tester the rubber diaphragm is used to prevent direct contact of the hydraulic liquid with the specimen. While it is desirable that the diaphragm interfere as little as possible in the transfer of pressure from the liquid to the specimen, it has seemed necessary to use rubber of sufficient thickness to insure against bursting the diaphragm when testing certain kinds of strong papers that give way in a small area. When this kind of failure occurs, a thin diaphragm may suddenly develop a weak fingerlike projection extending for some distance through a small rupture in the paper, especially if there is air in the system that expands when the pressure is released by the bursting paper.

In the design of the tester the diaphragm is put in as a disk of rubber clamped under a portion of the fixed (lower) clamping plate and is below the clamping plane of the paper by $^1/_8$ to $^1/_4$ in. In order to expand the paper enough to burst it, the rubber disk must be expanded through the lower orifice to reach the paper, and then beyond as much as the paper stretches. The height of the rubber dome may therefore sometimes be as much as $^3/_8$ in. Rubber thick enough to insure against dangerous ballooning when the paper bursts may, by having to stretch so much, adds appreciably to the pressure developed. Hence the true bursting pressure of the paper may be somewhat less than that registered on the gage.

It is quite common to assess the diaphragm error as the pressure remaining after the paper has burst. If the tester is stopped immediately after the specimen bursts, the clamp released, and the paper removed, the diaphragm will stand somewhat above the clamping

plane of the paper and some pressure will usually be shown by the gage. This residual pressure is sometimes several pounds per square inch, and is often looked upon as a measure of the diaphragm error. However, if there is air in the system (and there usually is), the pressure is not relieved to the extent assumed and the diaphragm expands considerably beyond the position occupied at the instant the paper bursts. The diaphragm pressure obtained in this way is usually considerably greater than the actual diaphragm error.

The following method will give a much better evaluation of the diaphragm error. Select typical papers representing the range of bursting pressures of interest. Make at least 20 tests on each, separating the test areas enough to allow a second set of tests to be made on the contiguous areas. Remove the upper, movable clamping plate. Retract the diaphragm below its clamping plane and fill the orifice above it with water, level with the top of the fixed clamping plate. Apply petrolatum or other grease to the top of the plate and lay over it a piece of very thin sheet rubber (0.002–0.003 in. thick, if available), working out air bubbles until the rubber film makes good contact with the water. Air bubbles, when present, show through the thin, translucent rubber. The grease film will help keep the rubber in place and prevent water from creeping out under it. Replace the upper clamping plate and retest the same papers as before on the contiguous areas reserved during the first set of tests. In these tests the thin rubber film will offer negligible resistance in stretching to form the dome, while the regular diaphragm below the water will not fill out enough to stretch at all. Hence the diaphragm error will be virtually zero. The difference in the two sets of tests, between the two averages for each paper will be indicative of the diaphragm error. During the second set of tests do not release the clamp until after the pressure has been relieved. Otherwise the water will be forced out under the rubber film.

The magnitude of the diaphragm error will depend on the type and thickness of the rubber, on the distance between the diaphragm and the paper specimen, and on the manner of putting in the diaphragm (whether tight or loose). Usually the last-mentioned factor is the most important.

The diaphragm error can be reduced by putting the diaphragm as near as practicable to the paper. On most old bursting testers the lower clamping plate is probably nearly $^1/_4$ in. thick near the orifice. This thickness of plate intervenes between the diaphragm and the paper. On newer testers this distance may have been reduced to $^1/_8$ in. The thinner plate is preferable wherever it can be used. In testing very strong papers, however, it may be necessary to use the thicker plate to help prevent slipping of the specimen in the clamp, but it should not be used for bursting pressures below about 50 p.s.i.

The diaphragm error can be further reduced by putting the diaphragm in with some slack. This can be done fairly easily if the entire underside of the rubber disk is wetted with the hydraulic liquid before it is put in place. Not only will there be less chance of trapping air bubbles under the disk, but when clamped down, the rubber disk will pucker enough to allow it to round out under the paper during a test without stretching appreciably. A slack diaphragm fastened under the thin clamping plate will produce little diaphragm error in the testing of ordinary papers.

Table I. Effect of Manner of Installing Diaphragm Under the Thick ($^7/_{32}$-In.) Diaphragm Plate on Bursting Strength of Papers

Paper	A, p.s.i.	B, p.s.i.	(B−A)/A ×100, %	C, p.s.i.	(C−A)/A ×100, %	D, p.s.i.	(D−A)/A ×100, %
Rope manila	70	70	0	68	−3	68	−3
Map	39	40	3	39	0	39	0
Newsprint	9.5	10.3	8	10.5	11	10.9	15
Paper towel	2.9	4.4	52	5.7	97	6.9	138
Tissue	2.8	3.2	14	3.5	25	4.9	75

A: Bursting pressure with 0.002-in. diaphragm on top of diaphragm plate.
B: Bursting pressure with 0.030-in. diaphragm, very slack, under diaphragm plate.
C: Bursting pressure with 0.035-in. diaphragm, slack, under diaphragm plate.
D: Bursting pressure with 0.035-in. diaphragm, little slack, under diaphragm plate.

For the range of bursting pressures from 10 or 15 p.s.i. to 200 or 250 p.s.i. the ordinary rubber diaphragm having a thickness of about 0.035 in., which is commonly used with the tester, is adequate if put in with some slack. A somewhat thinner diaphragm would probably do quite as well for testing most papers. For the range below 10 or 15 p.s.i., however, a fairly thin diaphragm such as dental dam should be used, also put in with some slack, and the thin clamping plate must be used.

Table I shows the results of bursting tests of several kinds of paper. Column A represents tests made without diaphragm error by the method described in the section above, in which a very thin diaphragm (0.002 in. thick) is used, initially in contact with the paper. The remaining tests were made with diaphragms 0.030–0.035 in. thick put in with varying amounts of slack. Column B represents tests made with a very slack diaphragm. Column C represents tests made with the diaphragm moderately slack. Column D represents tests made with a diaphragm having as little slack as possible. The percentage difference by which the results in each column differ from the corresponding results in column A is also shown. This difference is a measure of the diaphragm error. A thick clamping plate was used to emphasize the differences. There is not much difference in the results for the stronger papers—only about the normal differences attributable to the variation in the paper. The weak papers show progressively greater diaphragm error as the diaphragm becomes less slack.

Table II shows results for the same weak papers tested with a diaphragm of dental dam fastened under the thin ($^1/_8$-in.) clamping plate (column B) in comparison with tests made as in column A of Table I.

It is entirely feasible to require the diaphragm error to be negligibly small, since there is a method for determining it. There seems to be no point in specifying rigorously the thickness of the rubber to be used. I

Table II. Effect of Thin Diaphragm in Improving Bursting Strength Tests on Weak Papers

Paper	A, p.s.i.	B, p.s.i.	(B − A)/A ×100, %
Newsprint	9.3	9.4	1
Paper towel	3.0	3.1	3
Tissue	3.0	2.9	−3

A: Bursting pressure with 0.002-in. rubber disk on top of diaphragm plate.
B: Bursting pressure with 0.009-in. (dental dam) diaphragm under $^1/_8$-in. clamping plate.

is sufficient to designate an upper limit to prevent use of unnecessarily bulky material, and to recommend the approximate thickness of rubber which experience has shown to be adequate for use in a given range of bursting pressures.

Diaphragm Material

Different kinds of rubber that may be available for use as diaphragms may have different stretch characteristics. It is desirable when practicable to use a low-modulus rubber to minimize the diaphragm error. But it is not essential, since this factor can usually be subordinated to others, such as thickness of the rubber chosen, the amount of slack allowed, and the distance between the diaphragm and the paper specimen.

Natural rubber has always been used as diaphragm material for bursting testers. While oil is the liquid medium most used in hydraulic apparatus it is not compatible with natural rubber. Glycerol has been used chiefly in bursting testers. The less viscous ethylene glycol has recently been recommended (*3*) chiefly because it is easier to fill the gage tube with it than with glycerol. Since oil is commonly used in the piston-type apparatus for calibrating gages, it frequently finds its way to the diaphragm which, if made of natural rubber, may be weakened and distorted thereby. Oil is a better lubricant than the glycols, and a thin oil would even more easily replace air in the gage tube. If an oil-resistant synthetic rubber, having sufficient durability, were used as diaphragm material, oil could be used as the hydraulic liquid in the bursting tester, with the attendant advantages mentioned.

The pressure required to raise the diaphragm alone to a height as great as any likely need can be used as a helpful guide to a diaphragm installation that will result in little or no diaphragm error. A paper with about 6% stretch at failure in the machine direction, which is substantially more stretch than most papers have, would rise in the bursting test to about 5 mm. ($^3/_{16}$ in.) above the clamping plane of the specimen. If the pressure required to raise the diaphragm alone to this height is not more than one tenth the bursting pressure of the paper to be tested, and not more than 5 p.s.i. in any case, the diaphragm error will generally be negligibly small.

A convenient gage to aid in making this test is shown in Fig. 1. It is made of two blocks 5 mm. thick connected by a U-shaped spring, and is designed to cling to the movable clamping plate with the two blocks between the plates. Apply pressure to expand the diaphragm and sight across the bottom of the upper plate (while the plates are separated 5 mm. by the block gage) until the apex of the rising rubber dome reaches the line of sight, when the pressure should not be greater than one tenth the bursting pressure of any paper to be tested with it. This test is merely a guide. In case of uncertainty about the diaphragm error, it should be measured by the method of the section previously mentioned.

Mechanism of Diaphragm Error

Figure 2 shows diagrammatically three steps in the relation of diaphragm and specimen. At (*a*) is shown the clamping plane *D* of the diaphragm and that of the paper *P* before pressure has been applied. Some initial slack in the diaphragm is indicated, which comes about when the diaphragm is clamped under the plate. At (*b*) is shown the position usually attained when a relatively weak paper is burst, if there is little slack in the diaphragm or if there is excessive distance between the clamping planes *D* and *P*. In this case the pressure has not been sufficient to press the diaphragm into complete contact with the paper, and an annular space is left near the rim. This seems to be the condition in which the diaphragm error is at its worst.

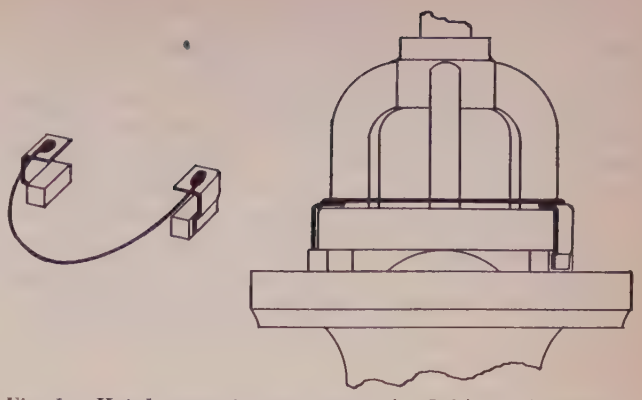

Fig. 1. Height gage in perspective (at left), and attached to the clamping ring (at right). The gage is used in judging the height to which the diaphragm alone should expand without appreciable registered pressure

Workers at the Pulp and Paper Research Institute of Canada, according to unpublished studies made some years ago, have inclined to the opinion that the error arises chiefly from the fact that normal pressure on the paper is applied only in the central area where complete contact of diaphragm and paper exists. The annular area is conical and only the central part of the test area is a spherical surface. According to this view, the paper behaves somewhat as if the effective size of the bursting orifice were reduced. This would produce a higher bursting pressure since, for a given paper, the bursting pressure is inversely proportional to the diameter of the orifice.

There is also the stretch of the rubber as a contributing factor. It is probable that where the rubber is in

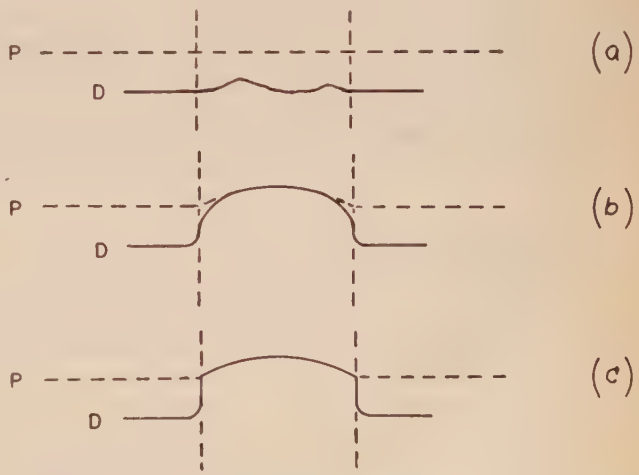

Fig. 2. Contour of the diaphragm: (a) before hydrostatic pressure is applied; (b) before complete contact is made with specimen (weak papers); (c) after good contact with specimen has been made

contact with paper or metal the pressure and friction tend to immobilize it against further stretch. But it can stretch freely in the narrow annular band where it does not touch anything. That part of the pressure required to keep this band of rubber stretched will not contribute to the expansion of the paper but will contribute to the gage reading, and therefore represents an error in the indicated bursting pressure of the paper.

Whichever mechanism is chiefly responsible for the diaphragm error, it is evident that it is advantageous to put the diaphragm in with enough slack to allow it to fill out under the paper and burst it without appreciable stretch of the rubber.

On the other hand, if the bursting pressure is great enough to allow the diaphragm to fill in the annular space and make complete contact with the paper, as shown at (*c*) of Fig. 2, at a pressure well below the bursting pressure, the first-mentioned mechanism will be completely inoperative and the second will be reduced. Above a pressure sufficient to make the rubber diaphragm conform to the contour below the paper, the additional pressure required to sustain a fairly flat arc of stretched rubber would be relatively small. This appears to be another reason (in addition to the percentagewise decrease) why the diaphragm error is of less importance for strong papers than for weak papers (see Table I).

TESTING RATE

When all bursting testers were hand-driven, a speed of operation of 120 r.p.m. of the handwheel became the standard. This speed corresponded to displacing hydraulic fluid into the pressure chamber at a rate of about 75 ml. per min. The advent of the motor-driven bursting testers brought higher operating speeds. The change seems unfortunate since the maximum-reading pressure gages used on the bursting tester perform better at lower speeds. About 1947 the Technical Association of the Pulp and Paper Industry (TAPPI) changed its standard (T 403 m) to specify a speed of liquid displacement of 95 ± 10 ml. per min., but apparently through an oversight retained the old speed for hand-driven testers. The American Society for Testing Materials (ASTM) still retains the old speed in its standard (D 774), but the change will probably be made in a revision now under consideration.

Perhaps the reason paper technicians have been somewhat indifferent about the discrepancy in testing rate is that they have not surely been able to detect in their tests the effect of the difference. And this, in turn, is probably because the speed of displacing liquid does not alone determine the effective speed of bursting the paper.

Evaluating Effective Testing Rate

When liquid is forced into the pressure chamber to create pressure to burst the paper, the resulting volume change is absorbed in three or four different parts of the pressure system. A part expands the sensitive element in the gage by which the measurement of the pressure is made possible. In the lower bursting range a part usually is absorbed in forcing the diaphragm into the annular peripheral recess and is not necessarily effective in expanding the specimen. A part is absorbed in compressing air in the system. The remainder expands the paper specimen into a substantially spherical segment, the enlargement of which culminates in the bursting of the paper. It is the relation of this last-mentioned part to the whole that determines the effective testing rate for a given rate of displacement of liquid in the pressure chamber. The measurement of these quantities will now be considered.

Rate of Displacement of Liquid. The rate at which the hydraulic liquid is displaced in the pressure chamber is determined by the size of the piston and its rate of travel. Usually the piston is driven by a screw connected through reduction gears to an electric motor. If one can determine the inside diameter of the cylinder in which the piston moves, the pitch of the screw thread, the gear reduction ratio, and the speed of the motor, one can readily calculate the rate of displacement of the liquid. The motor speed can be determined with a revolution counter, tachometer, or stroboscope.

Usually it will not be feasible to determine the displacement rate from the geometry of the system. However, it can be determined accurately by measuring the rate of displacement of the hydraulic liquid into a buret in the following manner: Attach the buret to the pressure chamber of the bursting tester in place of the gage and add more liquid until it stands a few inches above the diaphragm, adjusting the position of the buret if necessary. The small additional head applied during the measurement will not produce perceptible expansion of the diaphragm or the pressure gage. It is not advisable to use glycerol in the buret because of the difficulty of getting reliable readings with such a viscous liquid. Ethylene glycol is recommended instead. Turn the driving shaft over by hand and count the number of turns required to displace 10 ml. or so of liquid into the buret. The volume per turn multiplied by the number of revolutions per minute of the shaft gives the required rate of displacement of the liquid. For most motor-driven bursting testers this rate will be in the neighborhood of 95 ml. per min.

The determination can also be made by timing with a stopwatch the displacement of a given volume of liquid while the bursting tester is operating at normal speed. However, the quantities measured are small (10 or 15 ml. in 5 or 10 sec.), and the readings cannot be made as accurately under these conditions.

The rate of displacement of liquid can also be measured by the following method, which is less reliable than the others: close off the gages (or remove them and plug the openings). Count the number of turns of the driving shaft required to expand the diaphragm between two positions. The change in volume can be calculated from the height of the apex of the diaphragm above its clamping plane in the two positions and the diameter of the base of the spherical segment formed by the diaphragm. If the movable clamping plate is removed, the diaphragm heights can be measured with a depth gage inserted through the guide bearing.

Fraction of Displaced Liquid Under Paper Dome. That part of the displaced liquid that produces the expansion of the specimen during a given change in pressure is determined as the difference between the displacement when paper is expanded and when no expansion through the orifice is permitted. The pressure change selected for this purpose should bear a fairly definite relation to the bursting pressure. The

change from one fourth to three fourths of the expected bursting pressure is a convenient pressure interval to use.

The following method is suitable for the determination: clamp a specimen of paper in the bursting tester. Apply pressure until the gage reads about one fourth of the expected bursting pressure. Turn the driving shaft over by hand and count the number of turns required to increase the pressure to about three fourths of the expected bursting pressure. The number of turns multiplied by the volume of liquid displaced per turn of the shaft (determined above) will be the volume of liquid displaced during the pressure change. Replace the paper with a stiff metal plate that will not bulge under the pressure used, with a disk of filter paper underneath to allow the air to escape readily, and repeat the displacement determination through *exactly* the same pressure interval. The difference between these two displacements, divided by the former, is the fraction, F, of the total displacement that has brought about the change in volume of the paper dome.

Instead of counting the number of turns of the driving shaft to determine the displacement in the above procedure, the displaced liquid may be measured with a dilatometer (*3*) attached to the pressure chamber of the bursting tester. In either case it is evident that F can be expressed simply as the difference in the number of turns, with and without paper, divided by the number of turns with paper in the clamp, instead of in terms of actual volumes displaced.

In symbols, F is expressed in the following manner:

$$F = \frac{(D + S) - S}{D + S} = \frac{D}{D + S} = \frac{1}{1 + S/D} = \frac{T - t}{T} \quad (1)$$

in which D is the volume change under the paper dome during the pressure change, S is the volume change in the remainder of the system (gages, air, etc.) during the same pressure change, T is the number of turns of the driving shaft (or of the dilatometer screw) required to produce the pressure change with paper in the clamp, and t is the number of turns when the paper is replaced by the unyielding metal plate.

Apparatus Constant. The difficulty about determining and using F in the manner described above is that it is not really a constant of the apparatus because each paper used has a different value for D. In making bursting tests, wherein a given tester and gage are used to test all possible papers that come within the range of the combination, it is more practical to fix the quantity S. This quantity is characteristic of the apparatus, and for a given average or typical paper it determines F. It is not necessary actually to know F. Fixing the value of S within limits for any given combination of tester gage, diaphragm, etc., is sufficient.

For the determination of S some definite portion of the gage range should be chosen rather than to relate it to the bursting pressure of some paper, as was done in evaluating F. It is recommended that the middle half of the scale be used as the pressure range in evaluating S. It is always advisable to avoid the lower end of the scale, and there is some danger of applying too much pressure with an unyielding plate clamped in the tester when pressures near the limit of the gage are produced.

Allowable limits of S corresponding to a pressure change from one fourth to three fourths of the gage range (midhalf pressure change) have been estimated from data on gage characteristics given in a recently suggested revision of the bursting strength test sponsored by TAPPI (*4*), and based on work done at the Pulp and Paper Research Institute of Canada. The pertinent data from the report are given in the first three columns of Table III, and the derived data are shown in the latter part of the table. The expansion coefficient, E, has been defined (*3*) as the expansion in milliliters of an air-free gage per unit (p.s.i.) of pressure change. The pressures P_1 and P_3 are one fourth and three fourths of the maximum gage pressure; that is, $P_3 - P_1$ is the midhalf pressure change. The pressure P is the gage pressure produced by the displacement of 0.4 ml. of the hydraulic liquid with the testing orifice blocked off. The significance of P is explained below.

For all practical purposes S is the sum of the gage expansion and the air compression during the midhalf pressure change. The gage expansion is the product of the expansion coefficient and the pressure change; that is, $E(P_3 - P_1)$. The air compression is $V_1 - V_3$, in which V_1 is the volume of the air in the system at the pressure, P_1 and V_3 is the volume of this air at the pressure P_3. The maximum allowable value of $V_1 - V_3$ can be determined in the following manner.

The TAPPI report (*4*) referred to above fixes the maximum amount of air to be tolerated in the system by the requirement that, when the bursting orifice has been blocked off against any expansion through the orifice, the displacement of an increment of 0.4 ml. of the hydraulic liquid shall produce a gage pressure not less than P (Table III). The corresponding expansion of the gage element is PE, and the amount that this quantity is less than 0.4 ml. is the change in volume of the air in the system by compression; that is,

$$V_o - V_p = 0.4 - PE \quad (2)$$

in which V_o is the volume of the air in the system at atmospheric pressure, and V_p is its volume at the pressure P. The following gas-law equations, relating volumes and the corresponding absolute pressures, can be set down, the atmospheric pressure being taken as 15 p.s.i. (absolute):

$$15V_o = V_p(P + 15) = V_1(P_1 + 15) = V_3(P_3 + 15) \quad (3)$$

By combining equations (2) and (3) one obtains

$$V_1 - V_3 = \frac{15(P + 15)(P_3 - P_1)(0.4 - PE)}{P(P_1 + 15)(P_3 + 15)} \quad (4)$$

which gives the maximum allowable midhalf volume change in ml. of the air in the system when the proper quantities from Table III are substituted in the right-hand side. The values of S shown in Table III are the

Table III. Calculated Values of the Desirable Range of the Apparatus Constant, S

Gage range, p.s.i.	Gage expansion coefficient E, ml./p.s.i.	P_1, p.s.i.	P_1, p.s.i.	P_3, p.s.i.	Midhalf volume change — Gage E($P_3 - P_1$) ml.	Midhalf volume change — Air (max.) $V_1 - V_3$, ml.	Midhalf volume change — System (max.) S, ml.
0–30	0.011	12	7.5	22.5	0.165	0.161	0.326
0–120	0.004	35	30	90	0.240	0.071	0.311
0–300	0.001	90	75	225	0.150	0.038	0.188

P is the gage pressure produced by the displacement of 0.4 ml. of the hydraulic liquid with the testing orifice blocked off; P_1 and P_3 are one-fourth and three-fourths of the gage capacity; V_1 is the volume of air in the system at P_1 and V_3 is its volume at P_3.

maximum allowable volume changes in the system corresponding to a pressure change through the middle half of the scale for the gage ranges listed.

The least value of S in Table III is about 0.15 ml. for the 300-p.s.i. gage with no air in the system. The range 0.15 to 0.35 ml., calculated for the gages listed from the data in the committee report (*4*), represents the limits within which S should be fixed to aid in obtaining reproducible results with the bursting test. This range can be neatly specified as $S = 0.25 \pm 0.10$ ml., the value for the apparatus constant to be required of any bursting tester. Specifying the apparatus constant in this manner makes it unnecessary to specify the separate characteristics, such as the gage expansion coefficient and amount of air that can be tolerated for each type and range of gage. In other words, if a gage has the required precision and accuracy, and is compatible with the requirement for the over-all apparatus constant, there is no need to determine its various individual characteristics. One simply determines the value of S by clamping in the tester the metal plate (with filter paper underneath) and determines the displacement, by counting turns of the shaft or dilatometer screw (and knowing the displacement per turn), produced by increasing the pressure from one fourth to three fourths of the gage range. If S is not within the above limits, air is removed from the gage or from the system (or possibly in some rare cases added to it) until S has an acceptable value. The value of S should be redetermined, and adjusted, if necessary, every time a gage or diaphragm is changed, or when the pressure chamber is opened for any reason.

The effect of air in gages has been ably discussed by Tuck and Mason (*3*). Since many gages contain excessive air that must be removed to make them conform to the limits of the apparatus constant, a convenient apparatus for removing air is shown in Fig. 3. An aspirator filter pump will usually suffice for the vacuum source. It is attached to an elbow tube extending above the hydraulic liquid in the bottle as shown. A shorter tube, extending only through the stopper, is connected by means of pressure tubing to the gage. The vacuum is kept on the gage while under a head of the hydraulic liquid until the liquid completely replaces the air, or until sufficient air is replaced to make the gage conform to the requirement for the apparatus constant. To remove air to the best advantage turn the gage over and at various angles while it is under

Table IV. Some Typical Values of the Apparatus Constant, S, and the Displacement Fraction, F

Gage range, p.s.i.	*Apparatus constant* S, *ml.*	*Displacement fraction,*[a] F, *corresponding to* T *and* t *(observed)*	D = 0.4	*Kind of paper used in determining* F *(from* T *and* t*)*
0–15	0.89[b]	0.26	0.31	Mimeograph
0–30	0.11	0.76	0.78	Book
0–60	0.50[c]	0.44	0.44	Rope manila
0–60	0.19	0.68	0.68	Rope manila
0–160	0.16	0.73	0.71	Folder stock
0–200	0.24	0.70	0.62	Rope manila

[a] T is the number of turns of the driving shaft (or of the dilatometer screw) required to increase the pressure from one fourth to three-fourths of the average bursting pressure of the paper; t is the number of turns required to increase the pressure through the same interval when the paper is replaced by an unyielding metal plate; D in this table is the volume change under the expanding dome of a hypothetical, typical paper while the pressure is increased through this same interval.

[b] This gage was not a bourdon-tube type. It had a very large expansion coefficient even when the air had been replaced by liquid.

[c] Before the air was removed from the gage; the next entry is for the same gage after the air had been replaced with hydraulic liquid.

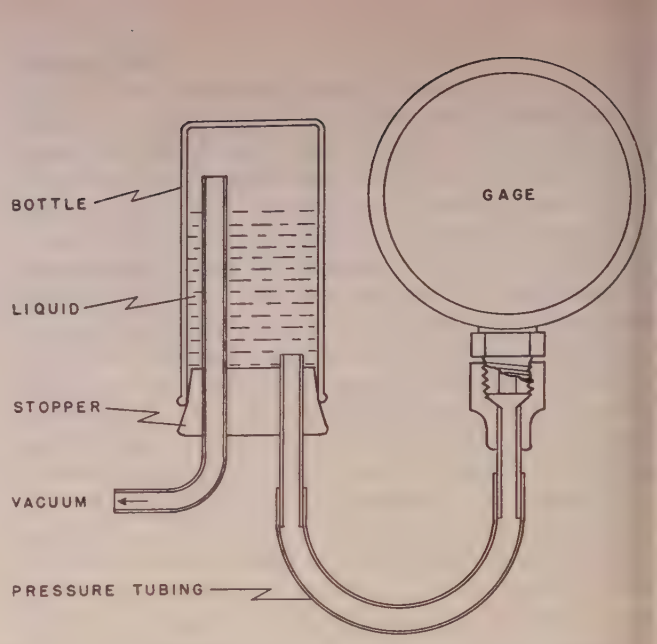

Fig. 3. A convenient apparatus with which to replace air in the gage tube with hydraulic liquid

vacuum, and allow sufficient time for the air to be replaced. It is difficult to fill a gage tube with glycerol; it is recommended that ethylene glycol be used instead. If necessary, glycerol can be made to replace the air if the gage is heated in an air bath during the replacement process.

In Table IV are shown typical values of the apparatus constant, S, for a bursting tester fitted successively with one of the several gages listed. In most cases the systems were substantially air-free. However, the evaluation was made for one gage (60-p.s.i.) before, as well as after, the air was removed, and the results illustrate how the air content can make the difference between conformance and nonconformance with the recommended limits of S. It is also sometimes possible to make S too small, as illustrated by the value for the 30-p.s.i gage. The first gage listed could not be brought within the limits even by complete removal of air from the system.

As a matter of interest values are included of F, the fraction of the displacement absorbed in expanding the paper dome through the midhalf pressure range, determined for various papers and also calculated by equation (1) for a hypothetical paper having a mid-scale dome expansion, D, of 0.4 ml.

The value of minimizing the diaphragm error and limiting the rate of expansion of the specimen is, of course, in the contribution that these measures make toward reproducibility of the bursting test. It has been found that bursting testers that could not previously be made to yield comparable results have, by attention to these maters, been made to agree satisfactorily.

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The Effect of Kraft Mill Waste Components on Certain Salmonoid Fishes of the Pacific Northwest

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This report is a summarized account of selective bioassays undertaken to determine the effects of kraft mill waste components on salmonoid fishes of the Pacific Northwest.

THE immediate purpose of this study was to determine the minimum lethal concentration of some of the chemical substances found in wastes of kraft mills. In addition, the critical concentrations were ascertained in the general course of investigation. This type of bioassay is important because it serves to "pinpoint" toxic constituents in a complex waste product and, knowing the degree of toxicity of these constituents, it is possible to arrive at a rational solution of waste disposal.

A cursory review of the literature indicated that the critical constituents of kraft mill effluent would be the mercaptans, sulphides, and resin soaps. Ebeling (*3*) concluded that the toxic effects of soda-sulphate wastes were caused by the resins, a concentration of 5 p.p.m. being fatal to fish, and that the aquatic insects were more resistant to the resin than the fish. Cole (*2*) found that the black liquor was definitely irritating to fish and that 1 p.p.m. of methyl mercaptan in lake water killed white bass (*Lepibema chrysops*) in 1.75 hr. or less; yellow perch (*Perca flavescens*), largemouth black bass (*Micropterus salmoides*), smallmouth black bass (*Micropterus dolomieu*), and bluegills (*Lepomis macrochirus*) in 6 to 8 hr.; and rock bass (*Ambloplites rupestris*) in 11 hrs. Ellis (*4*) found that the survival time of gold fish exposed to 10 p.p.m. of hydrogen sulphide ranged from 96 hr. to infinity. Van Horn, Anderson, and Katz (*6*) studying the lethal effect of kraft mill components to fresh water cyprinids of Wisconsin found the minimum lethal concentration of methylmercaptan and hydrogen sulphide to be 0.5 and 1.0 p.p.m., respectively.

The test fish used in the present study obtained from nearby streams were: king salmon (*Oncorhynchus tshawytscha*); silver salmon (*O. kisutch*), and coastal cutthroat trout (*Salmo clarkii clarkii*). Several attempts were made to employ hatchery-reared salmon and trout as test specimens, but these were found to be unsatisfactory for the purpose.

The minimum lethal concentration as used in this report is defined as the least amount of the toxic agent capable of producing 100 % mortality of the test fishes, and the critical concentration is the maximum amount of toxic substances tolerated by the test fishes without incurring any injury to them.

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METHODS AND PROCEDURES

Holding of Test Fish

After the fish were collected by seining and carefully transported to the laboratory, they were held for several days in a stainless-steel container of approximately 250-gal. capacity to determine their viability. The test specimens were kept in ordinary city water, which, by chemical analysis resembled the native waters from which the fish were obtained (Table I).

Table I. Analyses of Test Water Used in Bioassays

	Range
Dissolved oxygen, p.p.m.	9–12
Free CO_2, p.p.m.	1.0–2.0
Methyl orange alkalinity, p.p.m. ($CaCO_3$)	20–65
Chlorine (O.T.), p.p.m.	0.1
Specific conductivity, Mhos $\times 10^{-6}$ at 25°C.	1000–1200
pH	7.0–7.5

The fish were fed once daily during the holding period, the foods consisting of freshly ground crayfish and beef liver. Failure to feed the fishes, especially silver salmon, would frequently result in their biting each other's fins, resulting in marked injuries.

Selection of Test Fish

Fish used in the bioassays were selected for uniformity in size, age, good physical condition and place of origin. The size limits of young king salmon used throughout the tests were 9 to 12 cm. in total length; the silver salmon were slightly smaller, ranging from 7.5 to 11 cm.; and the coastal cutthroat trout ranged from 7.5 to 12 cm.

Aquaria

Cylindrical glass jugs of 18-liter capacity and 86.6 sq. in. of air surface proved to be more satisfactory than the conventional rectangular aquaria because of greater ease of handling, less physical injury to the test specimens, and no leakage. In a rectangular aquarium, the fish would frequently hit against the sides, resulting in injuries which often proved fatal; whereas, in cylindrical jugs they would merely swim in circles. All the jugs were covered on the outside with burlap sacking which prevented undue excitement of the test fish from outside sources.

Temperatures

Constant water temperatures were attempted during all toxicity tests. Regulation of temperatures in the summer months was accomplished by keeping a constant flow of tap water in the tanks used as water baths. The bioassays with king salmon, made during the sum-

mer months, were conducted at 17.5°C. ± 2°; those with silver salmon, made during the fall and early winter, were at 15°C. ± 3°; and with coastal cutthroat, made in late winter, at 12°C. ± 3°.

Test Solutions

All bioassays were conducted in solutions having 5.0 p.p.m., or more, dissolved oxygen. Experiments

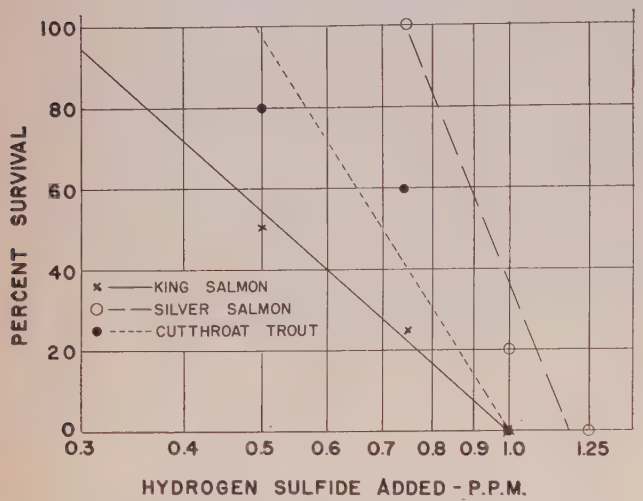

Fig. 1. The effect of hydrogen sulphide on king and silver salmon and coastal cutthroat trout

which at termination indicated D.O. contents below 5 p.p.m. were disregarded. It was found that two salmon or trout, averaging 10 cm. in length and weighing approximately 12 grams each, could be held in a test jug with 10 or 11 liters of solution for the period of the tests at 15°C. without aerating the water.

Test and Control Fishes

A minimum of 10 fish at each concentration was considered adequate to give fairly conclusive evidence in establishing minimum and critical concentrations. The control fish were always selected so as to be representative of the test specimens in regard to size, vigor, and place of origin. The duration of each bioassay extended over a period of 120 hr. and as each test fish died during the course of the experiment, it was removed from the jug, to prevent decomposition products from affecting the remaining live specimens.

RESULTS

The minimum lethal concentration of hydrogen sulphide for the three species of test fish as graphically shown in Fig. 1 ranged from 1.0 to approximately 1.2 p.p.m. The critical concentrations obtained by extrapolating the values to the 100% survival line, ranged from 0.3 to 0.7 p.p.m. Of the three species of fish tested the king salmon was the most sensitive to this chemical. Dissolved oxygen, pH, and alkalinity remained appreciably unchanged throughout the test periods.

The minimum lethal concentration range of methyl mercaptan was found to range from 0.9 to 1.75 p.p.m. and the critical concentration ranged from 0.5 to 0.9 p.p.m.; again the king salmon being more susceptible to methyl mercaptan than the other test species (Fig. 2).

No significant differences could be detected in dissolved oxygen, pH, and alkalinity at the various mercaptan concentrations and between start and completion of each test.

Figure 3 shows the minimum lethal concentration of sodium sulphydrate to range from approximately 2 to 3.5 p.p.m. The coastal cutthroat trout showed greater sensitivity to this chemical than the two other test species.

Table II. Summary of Results. Critical Concentration of Pure Chemicals in P.P.M.

Chemical	*King salmon*	*Silver salmon*	*Cutthroat trout*
Hydrogen sulphide	0.3	0.7	0.5
Methyl mercaptan	0.5	0.7	0.9
Sodium sulphide	1.8	1.3	1.0
Sodium sulphydrate	2.1	2.5	0.3
Sodium hydroxide	27	11	10
Sodium carbonate	58	44	33
Sodium sulphate	...	10,000	2500

The minimum lethal concentration of sodium sulfide as presented in Fig. 4 ranged from 3.0 to 3.5 p.p.m. and the critical concentration ranged from 1.0 to 1.8 p.p.m., the cutthroat trout showing less resistance to this particular chemical than the other test species.

Figure 5 shows the effects of sodium hydroxide on the three test species. The pH of the initial solution was increased somewhat by the addition of sodium hydroxide in excess of 20 to 30 p.p.m. At the completion of the test the pH was found to be normal for the solutions receiving the lower hydroxide additions. The minimum lethal concentration of sodium hydroxide ranged from 20 to 48 p.p.m. and the critical concentration from 10 to 27 p.p.m. The silver salmon and coastal cut-

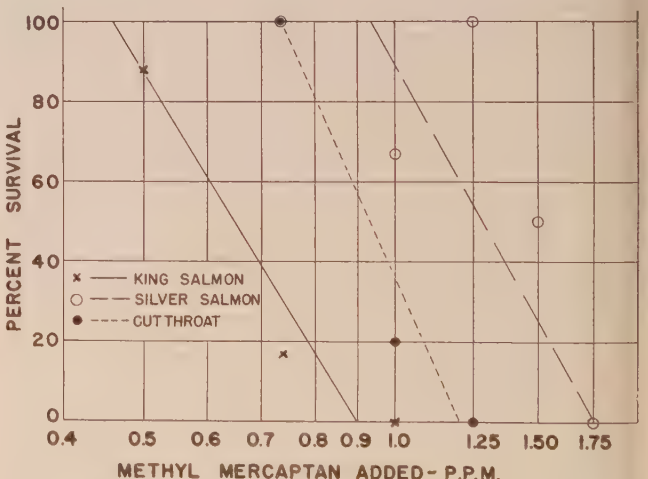

Fig. 2. The effect of methyl mercaptan on king and silver salmon and coastal cutthroat trout

throat trout were less resistant to this chemical than the king salmon.

The addition of sodium carbonate to the solution raised the pH and alkalinity of the test solutions. Generally speaking, pH values in excess of 9.5 as affected by the addition of alkali (sodium hydroxide or sodium carbonate) may have caused some mortality, the per cent mortality increasing with subsequent in-

creases in pH. Figure 6 shows the minimum lethal concentration of sodium carbonate to range from approximately 68 to 80 p.p.m. and the critical range from 33 to 58 p.p.m.

The effects of sodium sulphate and sodium thiosulphate were found to be more erratic than the results obtained from the other experiments. Generally speaking, extremely high concentrations of sodium sulphate and sodium thiosulphate were necessary to effect consistently 100% mortalities.

DISCUSSION

A summary of the results of the selective bioassays using pure chemical compounds presented in Tables II and III shows that hydrogen sulphide, methyl mercaptan, sodium sulphide, and sodium sulphydrate were more toxic to the three species of test fishes than the remaining chemicals employed. It can readily be seen from Tables II and III, that of the compounds tested, the amounts of sodium hydroxide, sodium carbonate, and sodium sulphate which would normally pass to the sewer would be insufficient to kill fish or fish food organisms. The critical constituents as shown by the results of these short range studies were the sulphides and mercaptans. Theoretically, there should be no significant difference between the three forms of sulphides used, namely, hydrogen sulphide, sodium sulphide, and sodium sulphydrate since they would be completely hydrolyzed. The prinicpal toxic ion at the pH of the test solutions in all three cases would be the SH^-, since the S^{--} ion is practically nonexistent at pH values below 11. By recalculating the sulphides added and basing the calculation on a common basis, namely S, it can readily be seen that the differences between the three sulphides used are less pronounced.

Table III. Summary of Results. Minimum Lethal Concentration of Pure Chemicals in P.P.M.

Chemical	*King salmon*	*Silver salmon*	*Cutthroat trout*
Hydrogen sulphide	1.0	1.2	1.0
Methyl mercaptan	0.9	1.75	1.2
Sodium sulphide	3.5	3.1	3.0
Sodium sulphydrate	3.3	3.5	1.8
Sodium hydroxide	48	20	35
Sodium carbonate	68	70	80
Sodium sulphate	...	16,500	6700

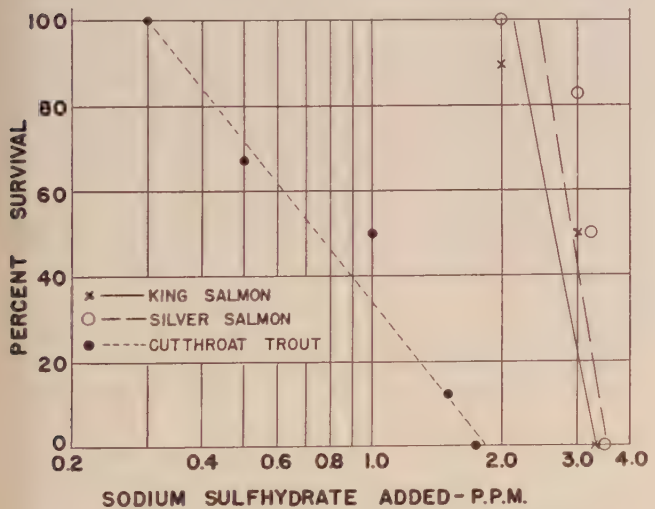

Fig. 3. The effect of sodium sulphydrate on king and silver salmon and coastal cutthroat trout

The toxic effects of sodium hydroxide and sodium carbonate are probably due to the increase in pH. From the tests conducted, it appears that pH values greater than 9.0 produced distress, the mortalities being proportional to the pH value.

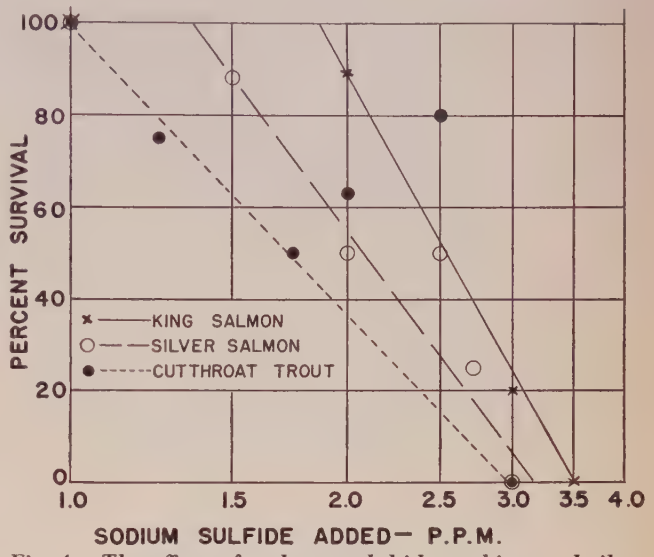

Fig. 4. The effect of sodium sulphide on king and silver salmon and coastal cutthroat trout

The critical and minimum lethal concentrations tabulated for the most susceptible of the three species to each chemical compound are given in Table IV. The use of this table in determining dilutions would serve to protect the most susceptible of the three species of fish used in these studies. Analyses of combined mill effluent from a modern kraft mill (*1*) employing a Bergstrom tower are presented in Table V. Basing dilutions on the maximum concentration in Table V and the critical concentrations for the most susceptible species and assuming the toxic constituents to be additive, a dilution of approximately 20:1 should be quite close to the threshhold limit for the salmonoid fishes.

Table IV. Critical and Minimum Lethal Concentrations of Pure Chemicals for the Most Susceptible of the Three Test Fish

Chemical	*Critical concentration, p.p.m.*	*Minimum lethal concentration, p.p.m.*
Hydrogen sulphide	0.3	1.0
Methyl mercaptan	0.5	0.9
Sodium sulphide	1.0	3.0
Sodium sulphydrate	0.3	1.8
Sodium hydroxide	10	20
Sodium carbonate	33	68
Sodium sulphate	2500	6700

A comparison of the relative sensitivity of silver salmon with that of some fresh-water cyprinids tested in Wisconsin by Van Horn, *et al.* (*6*), using the toxic components of kraft mill effluent (Table VI), shows some similarities and some striking differences. In

general, silver salmon from Oregon manifested a slightly greater tolerance to hydrogen sulphide, methyl mercaptan, and sodium sulphydrate. Silver salmon, however, were less resistant in solutions containing sodium hydroxide and sodium carbonate which may have been caused by the difference between Wisconsin and Oregon water supplies. The water used in the bioassays on salmon was poorly buffered and slight additions of alkali resulted in a marked increase in pH.

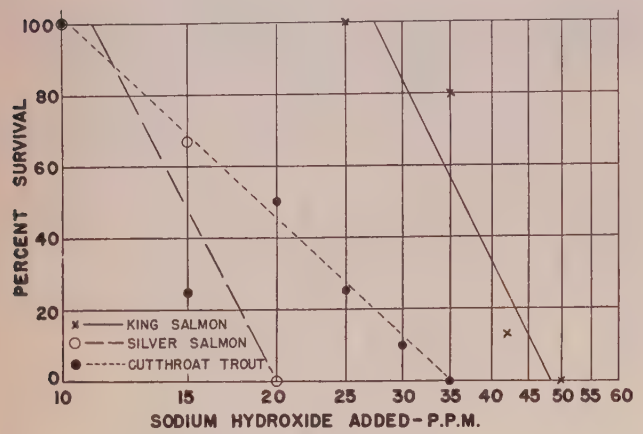

Fig. 5. The effect of sodium hydroxide on king and silver salmon and coastal cutthroat trout

In many cases the addition of 10 p.p.m. of sodium hydroxide increased the pH to 9.0 or more.

The greatest variation in susceptibilities was in the case of sodium sulphate. The marked high tolerance by salmonoid fishes of this salt, and, perhaps, in the case of sodium thiosulphate was probably associated with more highly developed salt-regulating structures found in the anadromous salmonoids. In this connection, it was suspected that a physiological age factor might exert considerable influence on the effects which some of

Table V. Chemical Analysis of Kraft Mill Effluent Primary Constituents

	Maximum concentration, p.p.m.	*Average concentration, p.p.m.*
Sulphides	0.5	0.07
Mercaptan	5.8	4.29
Active alkali	36.0	16.5

the chemicals had on these fishes. Since Pacific salmon and, in some cases, trout spend part of their lives in the ocean, they must possess some sort of a salt compensating mechanism. According to Keys (*5*), Atlantic salmon (*Salmo salor*, Linnaeus) possess such a mechanism. On the basis of one specimen, he thought that these cells were nonfunctional in the young Atlantic salmon. However, from cursory gill tissue examination and from the reactions of two chemicals used in the present studies, namely sodium sulphate and sodium thiosulphate, there were indications that the salt-regulating devices may develop in young king and silver salmon at different times within the same age group.

From observations of the test fish used in these experiments, it was noted that successful recovery from the effects of the chemicals depended largely upon the nature and concentration of the toxic substance involved and the time period of exposure in the chemical solution. The results of tests indicated that a large percentage of salmon and trout were capable of recovery from the effects of toxic concentrations of hydrogen sulphide and methyl mercaptan provided that they were immediately removed upon reaching the

Table VI. A Comparison of the Toxicity of Certain Components of Kraft Mill Effluents to Silver Salmon and Fresh Water Minnows of Wisconsin

Chemical	*Minimum lethal concentration, p.p.m.* Silver salmon	Wisconsin minnows
Hydrogen sulphide	1.2	1.0
Methyl mercaptan	1.8	0.5
Sodium sulphide	3.1	3.0
Sodium sulphydrate	3.5	0.5
Sodium hydroxide	20	100
Sodium carbonate	70	250
Sodium sulphate	16,500	100

"belly-up" position. On the other hand, exposure to the slower acting chemicals, such as sodium hydroxide and sodium carbonate, resulted in a few test fish making a complete recovery.

SUMMARY AND CONCLUSIONS

Selective bioassays were undertaken to determine the effects of kraft mill waste components on some salmonoid fishes of the Pacific Northwest. These selective bioassays were effective in determining the toxic range of some of the chemical constituents normally found in kraft mill effluents and, knowing the degree of toxicity

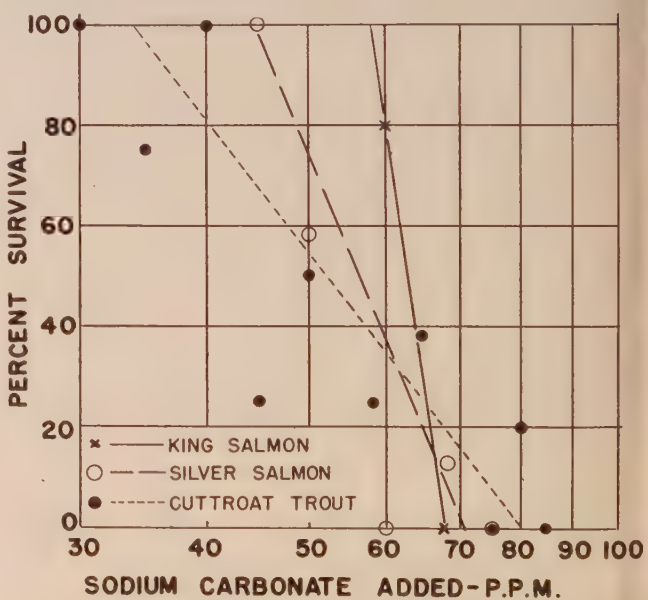

Fig. 6. The effect of sodium carbonate on king and silver salmon and coastal cutthroat trout

of these constituents, it is possible to arrive at a more rational solution of waste disposal. The results of the studies presented warrant the following conclusions:

1. Minimum lethal and critical concentrations for the most susceptible fish of the three test species to sulphides were approximately 0.5 and 1.0 p.p.m., respectively (calculated as S).

2. Methyl mercaptan produced distress and mortality at approximately the same concentration as the sulphides.

3. A large percentage of salmon and trout were capable of complete recovery from the effects of hydrogen sulphide and methyl mercaptan provided that they were immediately removed upon reaching the "belly-up" position.

4. The amounts of sodium hydroxide, sodium carbonate, sodium thiosulphate, and sodium sulphate that would pass to the sewer under normal kraft mill operation would be insufficient to kill salmonoid fishes of the Pacific Northwest. Of these four compounds, sodium hydroxide would be the most critical, having a threshold limit of approximately 10 p.p.m.

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The Action of Acid Chlorite on Wheat Straw

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Nine holocelluloses were prepared from wheat straw by successively increasing the time of reaction with acid chlorite from 1 to 9 hr. Hydrolyses showed that 55% of the arabinose, 58% of the xylose, and 17% of the glucose in the original straw were removed after seven treatments. Alcohol-insoluble polysaccharides were isolated from the chlorite liquors after removal of salts by ion exchange resins or by electrodialysis. These polysaccharides contained approximately constant amounts of glucose, arabinose, and glucuronic acid but an increasing quantity of xylose with time of reaction. The holocelluloses were nitrated and fractionally precipitated. Analyses of some denitrated fractions showed that nitrates of hemicelluloses and of cellodextrans were present in the most soluble fractions. A measure of the physical degradation of these nitrates and of the holocellulose nitrates was obtained from viscosity measurements. Chemical and physical degradation of the straw were most marked during the third hour of chlorite treatment.

The use of aqueous acetic acid-sodium chlorite solutions for the delignification of hard and softwoods was developed by Jayme (*1*). Wise *et al.* (*2, 3*) extended the applicability of the method by modifications of the original procedure. Bennett (*4*) prepared holocelluloses from various nonwoody plant materials and found that no more than 5% of the constituents producing furfural were lost during a 3-hr. treatment with acid chlorite. By adding the reagents at 15-min. intervals, Whistler *et al.* (*5*) were able to reduce the reaction time for corn cob delignification to 1 hr. Adams and Castagne (*6*) prepared holocelluloses from cereal straws with a 2 to 7% loss of pentosans. In all these investigations emphasis was placed on the removal of the lignin but the composition of the dissolved pentosans received little consideration. Interest in pentosan loss was aroused by the observation (*7*) that less arabinose was found in a hemicellulose prepared from wheat straw holocellulose than in a partially delignified hemicellulose isolated directly from wheat straw. It was anticipated furthermore that chlorite delignification might also cause physical degradation of both cellulose and hemicellulose chains. A number of investigators have determined the molecular weights of hemicelluloses isolated from holocelluloses by alkali treatment (*8, 9, 10*). By avoiding alkali treatment it was hoped that fractionation of holocellulose nitrates would yield separate hemicellulose and cellulose nitrates.

In the present investigation a series of wheat straw holocelluloses was prepared and the hemicelluloses dissolved by acid chlorite were estimated from a determination of the component sugars in the holocelluloses. These results were corroborated in part by the isolation of alcohol-insoluble polysaccharides from the chlorite liquors. Holocellulose nitrates were prepared and fractionated and viscosity measurements led to an appraisal of chain length degradation in the holocelluloses.

MATERIALS AND METHODS

Wheat straw was passed through a Wiley mill and sized on a Ro-tap screener. The fraction passing a 40-mesh screen and retained on 60 mesh was used in subsequent preparations. The straw was extracted successively with an alcohol benzene mixture (1 : 2) and 0.5% aqueous ammonium oxalate at 85°C. followed by a hot water washing according to the standard TAPPI procedure for wood (*11*). Pentosan was determined by distillation with 12% hydrochloric acid and the evolved furfural was measured by bromine oxidation (*12*). Uronic acid anhydride was determined by the method of Tracy (*13*), and lignin by the Klason method (*14*). Reducing sugars were determined by the Somogyi method (*15*), and the component sugars of the hydrolyzed polysaccharides by paper chromatography (*16*). Nitrate nitrogen was determined by the semimicro procedure of Gunning (*17*). Viscosity measurements were used to estimate the relative molecular weights of the fractionated nitrates (details are given in a later section). Moisture and ash were determined at 100 and 550°C., respectively.

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PREPARATION AND ANALYSIS OF HOLOCELLULOSES

Preparation

Nine samples (2 grams each) of the extracted, air-dried wheat straw were digested in water (100 ml. per sample) maintained at 75°C. for increasingly longer periods with hourly additions of sodium chlorite (1.5 grams) and glacial acetic acid (0.12 ml.) (*6*). After the requisite time of reaction the holocellulose suspension was filtered on a Buchner funnel through linen filter cloth, washed with water and acetone, and air dried before a final drying *in vacuo* over phosphoric anhydride. The holocellulose were numbered 1, 2, 3 . . .8, 9 to correspond with the duration of treatment with acid chlorite (1, 2, 3 . . .8, 9 hr.). Ash, pentosan, lignin, and uronic acid anhydride were determined (based on the straw) and hexosan content was estimated by subtraction from the holocellulose yield. Similar determinations were made on six holocelluloses prepared by the method of Whistler *et al.* (*5*).

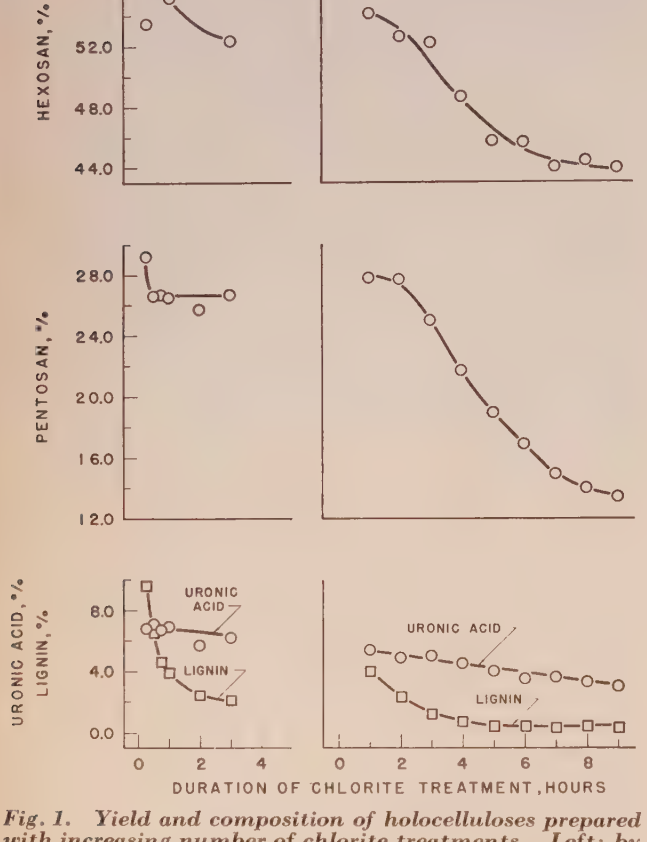

Fig. 1. Yield and composition of holocelluloses prepared with increasing number of chlorite treatments. Left: by Whistler method; right: by Wise method

Composition and yields of holocellulose obtained by the two procedures are plotted against duration of treatment in Fig. 1. The Wise *et al.* procedure (*3*) as modified by Adams and Castagne (*6*), (Fig. 1, right) led to a rapid drop in pentosan content after 3 hr. reaction. A noticeable leveling off in the hexosan content at 44% occurred after seven treatments but the pentosan continued to be removed even during the ninth hour though at a reduced rate. The milder reaction conditions of the procedure of Whistler *et al.* (*5*) did not remove pentosan after the first 30 min. (Fig. 1, left). After 2 hr. of either treatment the holocelluloses were almost identical in yield and in hexosan, pentosan, uronic acid, and lignin contents. About 22% of the pentosan of the original straw was lost when the lignin content was reduced to 1.2% while the loss was only 14% at a lignin content of 2.3% (Fig. 1, right). The uronic acid anhydride content of the holocelluloses prepared by the Whistler procedure remained essentially constant at 6 to 7% based on the straw whereas a continual loss was sustained in the holocelluloses prepared by the other method.

Hydrolysis of Holocelluloses and the Analysis of Hydrolysates

Two procedures were used: (1) The 3% sulphuric acid filtrate from a lignic determination was diluted to 1 liter and a 100-ml. aliquot neutralized with barium carbonate. The component sugars were determined by paper chromatography and the Somogyi procedures. Passage of a 100-ml. aliquot through an anion exchange resin column (Duolite A-3) was found to be an effective alternative to the use of barium carbonate. This resin held up no more than 1.2% of arabinose, xylose, or glucose when 1 to 15 mgm. of known mixtures of these sugars in 100 ml. of solution were passed through the column (60 cm. long by 2.5 cm. diameter) and washed with 200 ml. of water. The average values of the component sugars in the lignin hydrolysates are plotted in Fig. 2, while the straw hydrolysate contained 6.4% arabinose, 33% xylose, and 56% glucose. The graphs show that the elimination of arabinose was almost complete and occurred at an almost constant rate, while both xylose and glucose reached a limiting value after which none was further removed. The glucose yield (46%) was in excellent quantitative agreement with the hexosan content of the holocelluloses (44%) (Fig. 1, right). (2) A graded hydrolysis procedure was applied to 100-mg. samples of holocellulose using a syphoning apparatus maintained at 75°C. for 16 hr. while 100 ml. of 2*N* sulphuric acid dripped through continuously (*18*). The residue was dispersed in 72% sulphuric acid and left at 20° for 2 hr., diluted to 3% with water and boiled 4 hr. The solutions were de-ionized by the Duolite anion exchange resin and concentrated to a low volume before quantitative chromatography.

Analyses of the hydrolysates (Table I) indicated absence of arabinose and low xylose contents in the residues from holocellulose samples 3 to 9 inclusive after treatment with 2*N* sulphuric acid. In the holocelluloses prepared by 6 and 9-hr. treatments with chlorite, the ratio of glucose to xylose and the residue after 2*N* sulphuric acid hydrolysis was constant at 12 to 13 : 1, suggesting the presence of a residual cellulose-xylan complex or mixture. The 2*N* sul-

Table I. Component Sugars of Graded Hydrolysis of Holocelluloses

Sample No.	Yield of anhydro sugars, % wheat straw Arabinose	Xylose	Glucose	Total	Xylose: arabinose
2a[a]	1.6	7.7	nil	9.3	4.8:1
2b	4.4	14.4	16.0	34.8	3.3:1
2t	6.0	22.1	16.0	44.1	3.7:1
3a	2.4	9.6	2.1	14.1	4.0:1
3b	nil	1.7	31.7	33.4	...
3t	2.4	11.3	33.8	47.5	4.7:1
5a	1.9	7.4	nil	9.3	3.9:1
5b	nil	3.5	32.0	35.5	...
5t	1.9	10.9	32.0	44.8	5.7:1
7a	1.2	7.2	0.9	9.3	6.0:1
7b	nil	2.8	33.5	36.3	...
7t	1.2	10.0	34.4	45.6	8.3:1
9a	1.1	8.5	0.9	10.5	7.7:1
9b	nil	2.5	32.6	35.1	...
9t	1.1	11.0	33.5	45.6	10.0:1

[a] a—using 2 *N* sulphuric acid. b—using 72% sulphuric acid. t—total hydrolysate.

phuric acid had simply removed the more readily hydrolysable hemicelluloses and negligible quantities of glucose.

RECOVERY OF POLYSACCHARIDES FROM CHLORITE LIQUORS

Ten gram lots of wheat straw were treated with acetic acid-sodium chlorite for 3, 6, and 9-hr. intervals respectively (*6*). The chlorite liquor from each was de-ionized in an Aminco electrodialyzer at a current of 0.2 amp. for a period of 8 days. A second series of these three solutions was passed through IRA 400 anion exchanger, IR 100 cation exchanger, and Duolite A-3 in that order, thus removing all inorganic salts and lignin. Each solution was then concentrated to about 200 ml. and an insoluble polysaccharide was precipitated by addition of 800 ml. of 95% ethanol. The precipitates were then completely hydrolyzed by 2% sulphuric acid in 7 to 10 hr. Aliquots of the supernatant alcoholic liquor were concentrated and hydrolyzed for 6 to 8 hr. with 2% sulphuric acid. All hydrolysates were treated with barium carbonate in the usual way and chromatographed on paper. The only sugars detected by qualitative paper chromatography were glucose, xylose, arabinose, and traces of galactose. Uronic acids, extracted from the paper chromatograms, were calculated as glucuronic acid (*19*). The recovery from the papers was generally 90 to 100%.

The cumulative increase in carbohydrate dissolved by the acid chlorite and the composition of the alcoholic supernatant solutions and of the insoluble polysaccharides are shown in Table II. Recovery from the electrodialyzed solutions was about three times that from the ion exchanged solutions. The yield of soluble polysaccharides was calculated from the reducing values of the alcoholic solutions after complete hydrolysis. The insoluble residues, 6 ED-1 and 9 ED-1, were centrifuged off from the 6 ED and 9 ED solutions before the latter were diluted with four volumes of ethanol. Since these residues were composed entirely of xylose and glucose, it would appear that reasonably long chains of cellulose and xylan were split off together by the action of the chlorite.

If the insoluble polysaccharides are considered first it is apparent that essentially fixed quantities of arabinose (0.2–0.7%), glucose (0.1–0.3%), and glucuronic acid (0.1–0.4%) were removed during the first 3-hr. reaction and that subsequently only xylose (2.1–6.4%) was dissolved. Unfortunately insufficient material was available for a more detailed examination of the insoluble polysaccharides. The more readily hydrolyzable alcohol-soluble polysaccharides contained a maximum of 0.5% glucose, 0.2% glucuronic acid, and 0.6% arabinose which is approximately the same as in the insoluble polysaccharides. As with the insoluble polysaccharides, only the xylose content increased. The free reducing sugars of the alcohol-soluble polysaccharide solutions were calculated as a mixture of xylose, arabinose, and glucose. In quantity they do not exceed 0.5% of the straw. These values prove that acid chlorite degrades holocellulose into polysaccharides rather than free sugars. Thus the difference between alcohol-soluble and insoluble polysaccharides must be in molecular size rather than composition.

PREPARATION AND ANALYSIS OF HOLOCELLULOSE NITRATES

Preparation

In the preparation of nitrates from wood and straw celluloses Rassow and Dörr (*20*) used nitrating acids containing nitric and sulphuric acids and varying quantities of water. Higher yields of nitrates were obtained with materials having a low pentosan content. Increasing the water content of the acid, raising the temperature or lengthening the reaction time caused increased destruction of pentosans. Later investiga-

Table II. Yield and Composition of Alcohol-Soluble and Insoluble Polysaccharides from Chlorite Liquors

Time of preparation, hr.	Product and method of isolation		Yield, based on straw, %	Constituent sugars, based on straw, % Arabinose	Xylose	Glucose	Glucuronic acid
3	IE[a]	insol.	0.9	0.24	0.48	0.09	0.09
	IE	sol.	1.0	0.22	0.45	0.27	0.06
3	ED[b]	insol.	3.5	0.66	2.15	0.34	0.35
	ED	sol.	...	...	...	...	...
6	IE	insol.	1.5	0.23	0.94	0.23	0.09
	IE	sol.	1.1	0.23	0.62	0.18	0.07
6	ED-1	insol.	0.7	nil	0.16	0.29	nil
	ED-2	insol.	5.0	0.40	4.29	0.31	nil
	ED	sol.	2.0	0.20	1.16	0.43	0.20
9	IE	insol.	2.5	0.21	2.04	0.16	0.09
	IE	sol.	1.0	0.18	0.64	0.14	0.05
9	ED-1	insol.	0.4	nil	0.06	0.33	nil
	ED-2	insol.	7.4	0.56	6.43	0.19	0.26
	ED	sol.	4.3	0.62	2.97	0.47	0.22

[a] IE—solutions purified through ion exchange resins.
[b] ED—solutions purified by electrodialysis.

Table III. Variations in Holocellulose Nitrate Yield with Nitrating Acid

Nitrating acid	*Holocellulose nitrate, yield, %*	*Acetone insoluble, %*	*Acetone soluble, %*	*Nitrogen content, %*	*Acetone-water-soluble, %*
50:40:10[a]	67.5	4.6	69.1	11.5	...
40:40:20[b]	141.0	7.1	53.9	10.1	...
50:40:10	133.9	1.7	76.6	13.2	21.4[c]

[a] Heuser and Jörgensen's nonanhydrous acid.
[b] Staudinger and Mohr's anhydrous acid.
[c] 9.0% nitrogen.

tors substituted phosphoric acid and phosphoric anhydride for aqueous sulphuric acid in the nitration of cellulose and wood (*21, 22, 23*).

In trial experiments with holocellulose, 0.500-gram samples were nitrated with 50 ml. of each of the Heuser and Jörgensen acid (*21*), the Staudinger and Mohr acid (*22*), and an anhydrous acid (50 : 40 : 10) made in the proportions of 400 grams of 84% nitric acid, 89 grams of 85% phosphoric acid, and 222 grams of phosphoric anhydride. The nitrates, washed and stabilized by the method of Haas and Teves (*24*), were shaken with acetone until maximum solubility was attained. The insoluble fractions were then dried and weighed and the soluble portions were reprecipitated by pouring the acetone solutions into 1 : 1 acetone-water solution. Total recovery was obtained in one experiment by evaporating the supernatant aqueous solutions to dryness. The results (Table III) indicated that the anhydrous nitrating acid (50 : 40 : 10) gave a product with the highest percentage of acetone-soluble nitrate and of nitrogen. This acid was therefore used for subsequent nitrations.

One gram of each of the nine holocellulose samples (dried *in vacuo* over phosphoric anhydride for 4 days) was treated with 50 ml. of the anhydrous nitrating acid for 12 hr. at 0°C. After filtration the holocellulose nitrates were washed first with 300 ml. of cold 50% (v/v) aqueous acetic acid and then for 16 hr. with 6 liters of water. After drying *in vacuo* at 40°C. for 40 hr. and stabilization with methanol (*24*), the nitrates were re-dried and 1.0-gram samples were shaken for 16 hr. with 250 ml. acetone purified with silver oxide (*25*). Insoluble residues were recovered by centrifuging. The yields of purified, stabilized nitrates are recorded in Table IV.

Fractionation

The centrifuged nitrates were each treated with water until the appearance of a permanent turbidity. On heating to 40 to 50° the turbidities disappeared and the clear solutions were left for 16 hr. at 25° to reprecipitate. Repetition of this procedure gave three or four fractions from each before the remaining aqueous solutions were evaporated to dryness to obtain the final residues (*26*), cf. Table IV 1a to 1d, 9a to 9e, etc. Recovery of nitrates in this fractionation was 96% or better except in samples 1 and 3.

A number of the last fractions and residues from selected holocellulose nitrates were taken so that their total per cent exceeded the per cent of pentosan in the original holocellulose. These fractions were combined and refractionated from acetone solution by the addition of ligroin b.p. 40 to 60°. When no further precipitation could be obtained by the addition of the latter, the solution was evaporated to a low volume and poured into ligroin. The final residue was isolated by evaporating the supernatant liquors from this last precipitation. The yields of subfractions, e.g., 5t to 5z are recorded in Table IV. The first and second nitrate fractions in all series were fibrous white materials resembling matted cellulose while the remainder were difficult to recover from turbid suspensions and when dry were white electrostatic powders.

Viscosity and Relative Molecular Weights

Twenty-milligram samples of the refractionated nitrates were dissolved in acetone and made up to 10 ml. Aliquots of the latter were taken and each diluted to 10 ml. and the viscosities determined in an Ostwald-Cannon-Fenske viscometer (ASTM 50) in a water bath at 25°C. ±0.02. The plots of η_{sp}/C versus C were straight lines and were extrapolated to zero concentration to give the intrinsic viscosities $[\eta]$. These and the nitrogen contents are recorded in Table V. Intrinsic viscosities were also determined on the unfractionated nitrates and, using the constant referred to below, were converted into D.P.'s that are recorded in the third column of Table IV.

Since no values of the *Km* constant for xylan dinitrates were available, an attempt was made to obtain a number average molecular weight by osmometry using an osmometer designed by Donnan and Rose (*27*). When this attempt was unsuccessful, a Staud-

Table IV. Yields of Holocellulose Nitrates andSubtractions

Sample No.	*Purified nitrate, yield, %*	*First fractionation, % of total nitrate*						*Total recovery, %*
		D.P.	*a*	*b*	*c*	*d*	*e*	
1	110.5	2360	63.7	8.4	8.4	4.7	...	85.1
2	112.6	2260	51.3	24.0	6.4	13.7	4.0	99.4
3	114.8	1960	50.0	31.6	7.5	...	...	89.1
4	125.0	1860	...	...	...	...	...	...
5	130.9	1760	33.4	35.3	7.3	13.2	7.1	96.3
6	133.3	1720	56.1	23.7	12.7	3.3	...	95.8
7	128.6	1620	18.2	28.3	24.2	24.7	1.4	96.8
8	131.7	...	23.3	27.3	15.5	30.6	1.2	97.8
9	127.9	...	28.0	32.9	14.0	21.0	0.8	97.6

Combined fractions	*Refraction, % of total nitrate*							*Total recovery, %*
	t	*u*	*v*	*w*	*x*	*y*	*z*	
2b to 2e	23.6	7.3	3.4	7.9	1.4	2.5	...	46.1
3b to 3c	5.2	9.3	2.9	13.0	9.0	...	...	39.4
5c to 5e	2.1	2.0	4.5	5.9	8.6	2.4	2.1	27.6
8d	10.0	5.5	1.9	11.5	2.0	...	...	30.9

inger constant of 5×10^{-4} was assumed. Husemann (*9*) gives values ranging from 4.3×10^{-4} to 5.4×10^{-4} for mixed methyl and benzyl acetyl xylans, while those of the corresponding cellulose derivatives were 10 to 11×10^{-4}. Since the constants for cellulose nitrates are usually in the latter range (*21*, *22*, *24*) it was thought that the use of an arbitrary value of 5×10^{-4} for the present nitrates would not be unreasonable. This is all the more justifiable when it is noted that the *Km* values for cellulose nitrates drop with the content of nitrogen so that a cellulose nitrate with 11% nitrogen has a *Km* constant of 6.0×10^{-4} (*28*). In Table V the nitrogen contents are low enough to be in agreement with the postulate that the *Km* values for mixed hemicellulose and cellulose nitrates approach an assumed value of 5×10^{-4}. Even if a sample such as 8t with 12.9% nitrogen were pure cellulose, it would have a *Km* constant of only 8.2×10^{-4} (*28*). Using the constant, 5×10^{-4}, the relative degrees of polymerization of the refractionated nitrates were calculated from the intrinsic viscosities and recorded in Table V.

The intrinsic viscosities of the refractionated nitrates were anomalous in that the penultimate fraction of each series has a higher value than its predecessor (Table V, column 4). Other reversals of the expected order are noted in sample 5 but, unless this effect was caused by branched chains, it appears that precipitation by ligroin reaches a limited concentration after which precipitation into ligroin brings down longer chain material.

The Composition of the Refractionated Nitrates

Twenty-five milligram samples of the nitrates were denitrated with alcoholic ammonium polysulphide (*20*). Since recovery of insoluble polysaccharide was sometimes low, the acetone-carbon disulphide washings were concentrated *in vacuo* to a low volume in the presence of ethanol and then hydrolyzed with 2% sulphuric acid. The hydrolysates were treated with barium carbonate in the usual manner and the concentrated filtrates analyzed by paper chromatography. The results (Table V) show that some of the final nitrate fractions contained nitrates of hemicelluloses and of cellodextrans.

From a consideration of the data in Table V the following conclusions may be drawn: In sample 2, 23.6% of the holocellulose has a D.P. of 1900; 7.3%, a D.P. of 650 (2u); and 7.9%, a D.P. of 86 (2w). The latter is about 60% pentosan and, on the basis of the nitrogen contents of 2t and 2u, compared with 2w, it may be surmised that they contain less pentosan and more hexosan than 2w. This follows because hexosan trinitrates have a higher nitrogen content (14.1%) than pentosan dinitrates (12.6%). During the third chlorite treatment, some of 2t and all of 2u have been degraded to fractions of D.P. 278 (3w) and 306 (3u), observations corroborated by the high content of glucose in 3u and the similar nitrogen contents of the two fractions. Since the nitrogen contents of all but a minor subfraction of sample 3 are 10.8% or more and because of the lower recovery of nitrates (89.1%) in the first fractionation, it would appear that most of the hemicellulose nitrates of sample 3 were lost in the fractionation.

Five chlorite treatments have reduced the average D.P. to an even lower value. Fraction 5x (80% pentosan) and 5w (45% pentosan) are the major components, with the latter and 5v presumably derived from further degradation of the high hexosan-containing fractions. In fraction 8 a new effect is manifest, viz. the degradation of material that approaches 100% glucose. This material has been degraded to the three main fractions 8t, 8u, and 8w, all with D.P. greater than 400. Very little pentosan of D.P. 50 to 100 now remains in the holocellulose after eight chlorite treatments.

DISCUSSION

In these laboratories, the procedure adopted for the preparation of wheat straw holocellulose was treatment with aqueous chlorite for 3 hr. at 75°C. (*6*). These conditions were used, following the suggestion of Wise *et al.* (*3*), because they gave maximum recovery of holocellulose with the minimum content of

Table V. Degree of Polymerization and Sugar Composition of Refractionated Holocellulose Nitrates

Fraction No.	[η]	*Nitrogen, %*	*D.P.*	*Per cent of holocellulose nitrate*	*Component sugars, %*				
					Arabinose	*Xylose*	*Glucose*	*Galactose*	*Glucuronic acid*
2t	0.950	10.2	1900	23.6					
2u	0.325	10.7	650	7.3					
2v	0.082	9.2	164	3.4					
2w	0.043	9.2	86	7.9	3	55	3	14	24
2x	0.132	8.6	264	1.4					
2y	0.035	2.8	70	2.5					
3t	0.108	11.8	216	5.2					
3u	0.153	10.8	306	9.3	6	33	61	nil	nil
3v	0.121	7.8	242	2.9					
3w	0.139	11.0	278	13.0					
3x	0.058	11.0	116	9.0					
5t	0.016	8.6	32	2.1					
5u	0.074	9.8	148	2.0					
5v	0.131	10.8	262	4.5					
5w	0.096	10.6	192	5.9	21	22	51	nil	6
5x	0.025	9.5	50	8.6	5	76	8	nil	12.5
5y	0.045	10.1	90	2.4					
5z	0.035	5.3	70	2.1					
8t	0.595	12.9	1190	10.0					
8u	0.390	11.8	780	5.5	5	10	85	nil	nil
8v	0.208	11.7	416	1.9					
8w	0.247	11.9	494	11.5	7	17	67	nil	8
8x	0.011	2.8	22	2.0					

lignin. However, Fig. 1 (right) shows that a 2-hr. treatment with chlorite, while yielding a holocellulose with twice the quantity of lignin (2.3%) as the 3-hr. holocellulose (1.2%), results in a product with 8% more pentosans based on the pentosan content of wheat straw. Therefore, 2 hr. is the optimum time of reaction because the pentosan content of the 1 hr. holocellulose is no higher while the lignin content is 4.0%. Holocelluloses prepared by the Whistler *et al.* method (*5*) contain 3% less pentosan for a corresponding lignin content. In investigations where pentosan recovery is of major importance, the 2-hr. treatment by the modified Wise *et al.* procedure is to be preferred.

Previous research in these laboratories has shown that in wheat flour pentosans (*29*), wheat straw (*30*), and wheat leaf hemicelluloses (*31*), the pentosan materials contain primary xylan chains with arabinose side chains. The latter, being in the furanose form, were readily removed by mild hydrolysis, (0.05 *N* oxalic acid at 75°C. for 12.5 hr. (*29*)). Under the conditions described by Adams and Castagne (*6*), a 3-hr. chlorite treatment removed 25% of the arabinose and 30% of the xylose in the original straw. Continued chlorite treatments did not alter the ratio between these two sugars. Therefore, arabinose was not preferentially hydrolyzed, but the two sugars were removed concurrently at a molar ratio of approximately 5 to 1.

In addition to this chemical degradation, the graded hydrolysis data indicate that the chlorite produced a physical change in the holocellulose during the third hour of treatment. After 2 hr. the arabinose and xylose were hydrolyzed only to the extent of 27 and 35% respectively by 2 *N* sulphuric acid. However, after 3 hr. all of the arabinose and 80% of the xylose were removed. This sudden increase in hydrolysis suggests that the hemicelluloses were not completely accessible before the third hour chlorite treatment.

The isolation of polysaccharides containing glucose, arabinose, xylose, and glucuronic acid from the chlorite liquors affords conclusive proof that the degradative action of the chlorite treatment is quite general. The occurrence of glucose in these polysaccharides and its corresponding loss during the holocellulose preparations suggest that the source of this glucose was cellodextrans of low molecular weight. In an investigation of black sprucewood chlorite liquors, Bublitz (*32*) did not find glucose in an isolated polysaccharide. It is likely that either the short chain cellulose molecules were not present in spruce or the cellulose itself was protected to a greater extent by the lignin from the action of chlorite.

As the duration of chlorite treatment increased, the amount of xylose in the chlorite liquor polysaccharides also increased, while the arabinose content remained constant. However, the holocelluloses lost arabinose and xylose at a constant ratio of 1 : 5. Therefore, arabinose was preferentially hydrolyzed from either the chlorite polysaccharides or from the hemicelluloses in the wheat straw prior to degradation. The former hypothesis is more reasonable because of the great accessibility of the carbohydrate when in solution in the chlorite liquors. Either hypothesis is confirmed by the isolation of a water-insoluble xylo-glucosan from the electrodialyzed liquors. No sugars were found in a qualitative chromatogram of the alcoholic supernatant liquors from the polysaccharides (9 ED-2) isolated after 9 hr. of chlorite treatment. In other alcoholic solutions the maximum content of free sugars, calculated from the reducing powers, was 0.5% of the straw. Though there is a considerable difference between carbohydrate lost and carbohydrate recovered very little of this difference occurs as free sugars, presumably because of loss during electrodialysis or absorption on the ion exchange resins (*33*).

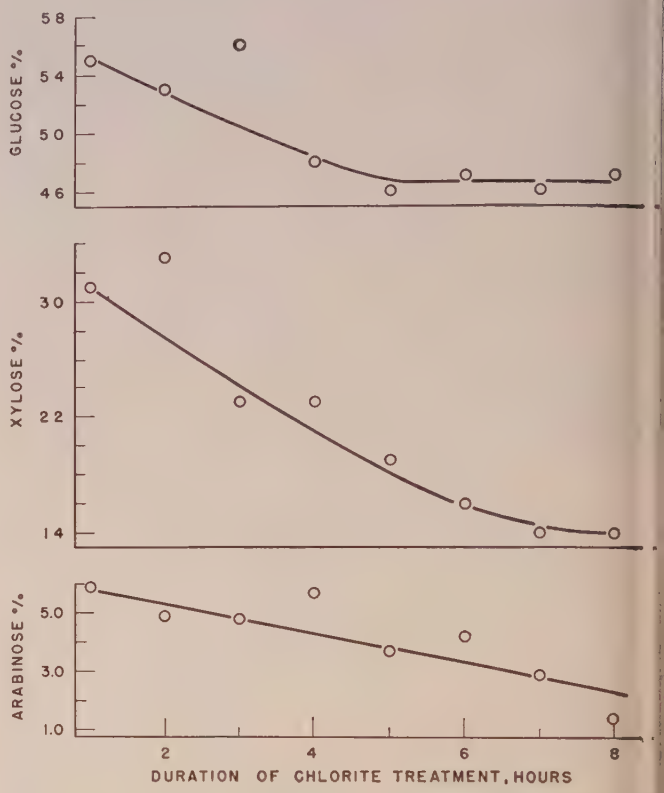

Fig. 2. Contents of glucose, xylose, and arabinose in holocelluloses prepared from wheat straw with acid chlorite

The decrease in yield of holocellulose with time of reaction is associated with both a loss in carbohydrate and a decrease in the average molecular weight of the products. An interesting comparison may be made with the results for paper birch wood as reported by Timell and Jahn (*34*). They found that after the 7 hr. required to delignify to a level of 0.6% lignin, the reduction in D.P. during the first to seventh hour of treatment was 21%. In the current investigation (Table IV), the decrease from the first to the seventh treatment was 31%. The greater degradation of wheat straw holocellulose can undoubtedly be attributed to the more ready removal of lignin from the wheat straw and the consequent increased accessibility of the carbohydrates to the degrading action of the reagents. This is substantiated by the observation that lignin-free cotton linters were reduced in D.P. by 36% during the first to sixth treatments (*34*). The corresponding reduction for the wheat straw holocellulose was 27%.

While it was possible to follow the over-all physical degradation of the holocellulose, it was impossible to see how the hemicelluloses were affected by the chlorite. The holocellulose nitrate was fractionated into cellulose nitrate and mixtures of hemicellulose and cello

dextran nitrates but the degradation of the hemicellulose nitrate component could not be followed specifically.

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Physical Properties of Slash Pine Semichemical Kraft Pulp and of Its Fully Chlorited Component

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A semichemical kraft pulp, its chlorited component, and a chemical kraft pulp were prepared from slash pine. The strength properties of the semichemical pulp were lower than the corresponding properties of the chemical pulp. However, the latent strength of the former was developed through treatment with acidified sodium chlorite. This resulted in a pulp with strength properties that were generally higher than those of the chemical pulp. The principal reason for the differences in strength between the semichemical and the chemical pulp was that the former did not have as many fibers per sheet cross section among which to distribute the load. After chloriting, the strength of the semichemical pulp was increased because (1) there was a larger number of fibers per sheet cross section; (2) the flexibility and degree of swelling of the fibers increased, which improved the opportunities for fiber-to-fiber bonding; (3) the weighted average fiber length did not change on refining; and (4) the surface properties were changed so that sheets with higher degrees of bonded area and bonding strength could be formed.

Semichemical pulping consists of any mild chemical treatment to soften and/or remove a portion of the fiber-bonding material, followed by a mechanical treatment to complete fiber separation. The yield can range from approximately 60 to 90%, depending on the amount of cooking chemicals used and the length of the cooking cycle. High-yield pulps can be produced by conventional cooking processes such as sulphate, acid sulphite, and soda. In addition, a neutral sulphite semichemical process has been developed, using sodium sulphite and sodium carbonate in the cooking liquor. In a recent review of semichemical pulping, Chidester (*1*) stated as a general conclusion that the strengths of the softwood semichemical pulps are much lower than those of the more completely delignified chemical pulps; yet the reasons for these differences have not been thoroughly studied.

Ratliff (*2*) has shown that the strength properties of a high-yield kraft pulp from slash pine can be greatly improved by treating the semichemical pulp with acidified sodium chlorite, a method developed by Jayme (*3*) and modified by Wise and co-workers (*4*). In this procedure the lignin is removed from the pulp with very little dissolution and degradation of the carbohydrate portion of the fiber.

The primary objective of the present investigation was to determine the nature of the changes produced in the fiber by the chlorite treatment which resulted in the altered strength properties.

PREPARATION OF THE KRAFT PULPS

Slash pine (*Pinus caribaea* Morolet) was selected because previous investigations (*2*) had been made using this species. Four freshly cut sticks (two fast growth and two slow growth) were obtained from a source near the Coosa River in Alabama. The fast growth logs had an average age of 17 yr. and grew at a rate of 2.9 rings per in. The moisture content of the wood was 61.0%, and the specific gravity was 0.46. The slow growth logs were 58 yr. old and had a growth rate of 10.6 rings

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per in. The moisture content of the wood was 42.8%, and the specific gravity was 0.57. The specific gravities were based on the oven-dry weight and oven-dry volume. The moisture content was based on the wet weight.

The four logs were barked by hand and chipped to produce 0.75-in. nominal length chips. These were screened on a 0.25-in. mesh wire screen and hand sorted to remove knots, slivers, and oversize pieces. All the chips were thoroughly mixed and sampled for moisture content and chemical analysis.

A résumé of the cooking conditions and yields is presented in Table I. The semichemical pulp was defibered in a Bauer refiner, screened, and the rejects sent through the Bauer again and rescreened. For each pulp the quantity of screenings was less than 1%.

Table I. Cooking Conditions and Yields for Semichemical and Chemical Kraft Pulps

Pulp	*Semichemical*	*Chemical*
Chip charge, g. (oven-dry basis)	14,150	5730
Moisture content of chips, %	42.8	42.8
Active alkali (as NaOH), %	8.0	24.0
Sulphidity, %	20.0	20.0
Water ratio, cc./g.	4.5	4.5
Maximum temperature, °C.	173	172
Time to max. temperature, min.	60	60
Time at max. temperature, min.	0	120
Time to relieve, min.	10	15
Total time, min.	70	195
Unscreened yield, %	73.7	44.2

The chlorited semichemical pulp was prepared similarly to the method reported by Ratliff (*2*) but under the following conditions. Each of three charges consisted of 800 grams (oven-dry basis) of semichemical pulp made up with water to 5% consistency. This suspension was given four 30-min. treatments with acetic acid and sodium chlorite, each treatment consisting of 330 grams of glacial acetic acid and 260 grams of sodium chlorite. The reaction was carried out at 70 to 80°C. and a pH of 4 to 5. Technical grade sodium chlorite was added in the form of a concentrated solution which was standardized before use. The yield of the chlorited pulp (oven-dry wood basis) was found by small scale procedures to be 54.6%.

STRENGTH CHARACTERISTICS OF THE PULPS

In a preliminary evaluation of the strength characteristics of these pulps, the bursting strength, tearing strength, tensile strength, and folding endurance were compared. The pulps were refined in the Abbé pebble mill according to TAPPI Standard T 224 sm, and were formed into sheets and tested according to TAPPI Standards T 205 m and T 220 m, respectively. The data are presented in Table II.

In general, the strength of the chlorited pulp was about 15% higher and that of the semichemical pulp about 45% lower than that of the chemical pulp. However, on this basis, the number of fibers per sheet cross section that were subjected to the stress was greatest in the chemical pulp and least in the semichemical pulp. This was due to the difference in the yields of pulp from the wood. If the strength values in Table II were converted to a basis whereby the number of fibers per sheet cross section was equal (constant fiber basis), the strength of the semichemical pulp would be increased and that of the chemical pulp would be decreased in relation to that of the chlorited pulp. In fact, the strengths of the semichemical and chemical pulps would be approximately equal. This can be substantiated by calculations from Table II. One of the more significant differences in these pulps was the beating times necessary to produce a given Schopper-Riegler freeness.

Table II. Preliminary Physical Evaluation of the Pulps

Beating time, hr.	*Schopper freeness, ml.*	*Basis weight*[a]	*Apparent density*[b]	*Burst factor*[c]	*M.I.T. fold*	*Breaking length, meters*	*Tear factor*[d]
			Semichemical Pulp				
0	895	46.0	6.1	15	0	1,000	1.27
2	880	44.7	6.8	24	6	2,180	1.15
7.5	565	47.9	10.1	55	63	4,850	0.84
9	375	47.5	11.3	57	97	5,080	0.71
			Chlorited Semichemical Pulp				
0	860	47.3	10.8	87	220	5,620	2.61
1	770	48.7	12.8	130	673	8,710	1.41
2.2	565	49.1	14.5	142	1020	9,100	1.14
3	370	46.5	15.5	148	1970	10,400	0.92
			Chemical Pulp				
0	880	46.8	8.8	47	40	3,790	4.02
2	840	49.9	12.3	113	656	7,090	1.98
4.7	470	46.8	15.2	123	1430	8,140	1.29
6	255	45.6	15.5	127	1780	8,630	1.19

[a] Pound (25 × 40—500).
[b] Basis weight/caliper (mils).
[c] Points/100 lb.
[d] Grams per sheet/basis weight.

A more complete investigation of the tensile strengths and tearing strengths of the semichemical and chlorited pulps was made. The handsheets were prepared as above except that, in lieu of a polished plate, the sheets were pressed and dried between Whatman no. 1 filter papers in order to produce sheets with two matte surfaces. Basis weight, apparent density, and tearing strength were determined by TAPPI Standard T 220 m. Tensile strength and stretch of a 1.5-in. test strip were measured with the Baldwin-Southwark Universal Tester as described by Fisher (*5*). In some instances an estimated standard deviation from the mean ($\sigma_{\bar{x}}$) was calculated (*6*) and reported as a range composed of the lowest and the highest deviation for each property of the pulp. Tests for the significance of a difference in the data were based on 95% ($2\sigma_{\bar{x}}$) confidence limits.

For an effective comparison of various pulps their strengths at several beating intervals were required. Table III contains data which indicate the effect of beating on the strength characteristics of the semichemical and the chlorited semichemical pulps. The beating intervals were so chosen that the strength properties over a wide range of Schopper-Riegler freeness values could be compared.

Under semichemical pulp in Table III the columns headed by the letter A contain the data to be compared with those of the chlorited pulp on a constant weight basis. The basis weights of these sheets were approximately 66 grams per square meter but, for the purpose of comparison, the strength values were corrected to a basis weight of exactly 66.0 grams per square meter. On this basis the tensile strengths of the chlorited pulp were much higher than those of the semichemical pulp. In addition, the tear factor was generally higher for the chlorited sheets.

The increase in the tensile strength as a result of chloriting was probably due to the following factors:

Table III. The Effect of Beating on the Strength Characteristics

Sheet property	Semichemical A	Semichemical B	Semichemical A	Semichemical B	Chlorited semichemical A	Chlorited semichemical B	Chlorited semichemical	Chlorited semichemical	Chlorited semichemical
Beating time, hr.	4.9	4.9	6.5	6.5	8.1	8.1	0.8	1.6	2.4
Schopper freeness, ml.	860	860	630	630	410	410	805	645	445
Basis weight, g./sq. m.	66.0	89.0	66.0	89.0	66.0	89.0	66.0	66.0	66.0
Apparent density, g./cc.	0.41	0.43	0.46	0.49	0.51	0.55	0.62	0.63	0.68
Tensile strength,[a] lb.									
$\sigma_{\bar{x}}$: 0.2–0.4	19.5	28.2	21.0	31.4	26.6	36.5	43.5	47.5	53.0
Breaking length,[a] m.									
$\sigma_{\bar{x}}$: 30–70	3540	...	3790	...	4800	...	7880	8590	9580
Stretch,[a] %									
$\sigma_{\bar{x}}$: 0.1	2.8	3.4	3.1	3.6	3.5	4.0	5.0	5.6	5.6
Tear factor,[b] g. per g./sq. m. (100)									
$\sigma_{\bar{x}}$: 0.7–1.2	80.7	...	61.7	...	57.8	...	105.3	80.1	67.6
Tearing strength,[b] g./sheet	...	...	...	62.4	...	...	69.7	52.9	44.6

[a] Average of ten determinations.
[b] Average of five determinations.

(1) During the reaction between the acidified sodium chlorite and the semichemical pulp various components were removed from the cell wall which decreased the average weight per unit of fiber length. By so doing, the number of fibers per sheet cross section in the chlorited sheet was increased over that in the semichemical sheet. Thus, for any given load on a test specimen, the forces in the chlorited sheet would be distributed among a greater number of fibers per specimen cross section, which should result in a higher ultimate strength similar to the effect created by an increase in the basis weight. (2) The chlorited sheet had a higher apparent density which indicated that there were greater opportunities for fiber-to-fiber bonding than in the semichemical sheet. (3) There were probably changes in the intrinsic fiber strength and in the effect of beating on the fiber length. (4) There were probably changes in the number and the strength of the fiber-to-fiber bonds.

The tearing strength is dependent upon three pulp properties: (a) the total number of fibers participating in the sheet rupture, (b) the fiber length, and (c) the number and strength of the fiber-to-fiber bonds (*7*). Factors (b) and (c) determine the fraction of the fibers that are pulled intact from the sheet and the fraction that are broken during the tear. Tearing strength generally increases with an increase in the number of fibers that are pulled from the sheet. The increase in the tearing strength as a result of chloriting was probably due to a larger number of fibers participating in the tear and to factor (3) in the preceding paragraph.

In order to eliminate the effect of the different number of fibers per sheet cross section, this factor was made constant by increasing the basis weight of the semichemical pulp by a ratio of the yield of the semichemical pulp to the yield of the chlorited pulp (oven-dry wood basis). The basis weights of these sheets were approximately 89.0 grams per square meter and again the strength values were corrected to a basis weight of exactly 89.0 grams per square meter. The data on these sheets are presented under columns B in Table III. On this basis (constant fiber basis), the tensile strengths of the chlorited sheets were still higher than those of the semichemical sheets. However, the tearing strengths of the chlorited sheets were slightly lower than those of the semichemical sheets.

By increasing the pressure in the wet pressing operation, it was possible to increase the apparent density of the semichemical sheets, refined for 6.5 hr., from 0.49 to 0.64 gram per cubic centimeter with a corresponding increase in the tensile strength from 31.4 to 38.0 lb. The tearing strength, in turn, decreased from 62.4 to 41.0 grams per sheet. These changes in the strength properties were probably due chiefly to increases in the number of the fiber-to-fiber bonds in the semichemical sheet. The remaining difference in the tensile and tearing strengths between the semichemical and the chlorited pulps should be due to factors (*3*) and (*4*) mentioned previously.

It was noted that, during the preparation of the handsheets, more fines were lost in the white water of the semichemical pulp than in that of the chlorited pulp. Therefore, the effect of changing the content of fines in the sheet on the strength properties was investigated. A semichemical sheet, refined for 6.5 hr., contained approximately 6% of fines (less than 150 mesh). When these fines were removed from the pulp by the Bauer-McNett classifier, the tensile strengths of the subsequent sheets were decreased by 13% and the tearing strengths were increased by 24%. In a chlorited sheet,

Table IV. Chemical Analyses of the Pulps and of the Original Wood

(Oven-Dry Wood Basis)

Material	Wood	Semi-chemical pulp	Chlorited pulp	Chemical pulp
Yield, %	100.0	73.7	54.6	44.2
Extractives, %				
Ethanol-benzene (1:2)	2.7	0.8	0.1	0.1
Ethanol (95%)	0.1			
Hot water	1.2			
Lignin, %	27.5	20.0	2.3[a]	1.5
Pentosan, %	8.5	6.0	5.3	3.1
Alpha-cellulose, %	46.8	41.5	43.3	37.0
Pentosan, %	1.0	0.7	0.8	0.9

[a] Lignin content calculated from the loss of material from the chloriting, corrected for extractives and pentosans.

Table V. Fiber Cross-Sectional Measurements

(Dry)

Property	Semichemical Sp.	Semichemical Su.	Semichemical To.	Chlorited Semichemical Sp.	Chlorited Semichemical Su.	Chlorited Semichemical To.
Fibers measured	36	42	78	38	43	81
Cross area, sq. mu	643	613	627	554	511	531
Std. dev.	30	29	21	36	27	22
Net area, sq. mu	396	537	471	323	440	385
Std. dev.	14	23	16	18	21	15
Width, mu	45.0	34.2	39.2	43.0	31.2	36.8
Std. dev.	1.4	0.7	1.0	1.7	0.9	1.1
Thickness, mu	21.5	23.9	22.8	19.4	21.6	20.5
Std. dev.	1.1	0.8	0.7	1.2	0.7	0.7
Width/thickness	2.34	1.48	1.87	2.59	1.48	1.99
Std. dev.	0.15	0.04	0.09	0.22	0.04	0.12
Roundness factor, %	42.3	65.8	55.0	39.4	65.9	53.5
Std. dev.	2.4	1.4	1.9	2.2	1.6	2.0
EFWT, mu	4.44	7.74	...	3.80	6.95	...
Std. dev.	0.16	0.20	...	0.17	0.20	...

Sp.—springwood fibers.
Su.—summerwood fibers.
To.—total fibers (composite).
Std. dev.—standard deviation from the mean.
EFWT—equivalent fiber wall thickness.

refined for 1.6 hr. there was 4% of fines and, after their removal, the tensile strengths of the sheets were decreased by 12% and the tearing strengths were increased by 17%. These changes were probably the result of a decrease in the number of the fiber-to-fiber bonds in the sheet. The effects of the fines on the strength characteristics were approximately of the same order of magnitude for each pulp and, thus, did not affect their relative strength differences.

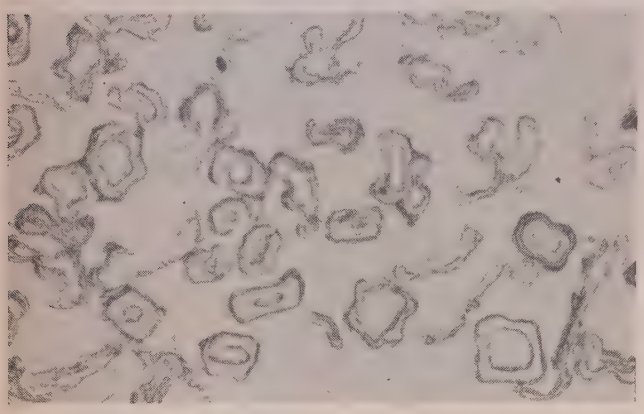

Fig. 1A. Semichemical cross sections (250×). Dry

CHEMICAL EVALUATION OF THE PULPS

In an investigation of the effect of the several chemical treatments on the chemical properties of the wood, determinations were made of the extractives, lignin, pentosan, and alpha-cellulose contents of the wood and pulps. The analytical data are presented in Table IV. In all cases, except where noted, the analyses were made in accordance with TAPPI methods. In the alpha-cellulose determination the material was pretreated with acidified sodium chlorite to remove the lignin as suggested by Cundy and Beck (*8*). The lignin content of the chlorited pulp could not be determined directly. It was calculated from the loss of material from the chloriting, corrected for extractives and pentosans. The extractions were successive.

The chemical action of the acidified sodium chlorite on the semichemical pulp seemed to be mainly the removal of lignin from the fiber. However, a small amount of pentosans was dissolved from the pulp; and, if the behavior of the pentosans is typical of the hemicelluloses in general, small amounts of mannan and uronic anhydride were also removed. It was shown by a methoxyl determination that the isolated lignins from the wood and from the semichemical pulp contained a negligible quantity of carbohydrate material. The lignin from the pulp had 15.4% methoxyl, that from the wood 16.3%.

PHYSICAL EVALUATION OF THE PULPS

Microscopic Examination of the Fibers

A microscopic examination of the fibers was made in order (1) to obtain a measure of the changes in the thickness of the cell wall and in its state of collapse produced by the action of the acidified sodium chlorite, (2) to obtain some measure of the change in the swelling properties of the fibers as a result of the chloriting, (3) to observe the effects of refining on the surfaces of the fibers, and (4) to study the distribution of the lignin in the semichemical fibers.

The higher density of the chlorited sheets may have been due to a higher percentage of collapsed, ribbonlike fibers. An increase in the percentage of collapsed fibers or in the state of collapse of the fibers is probably related to an increase in the width-thickness ratio and to a decrease in the roundness factor—a ratio of the gross area to the area of the circle circumscribing the cross section, expressed in per cent. The wall thickness was estimated by calculating an equivalent fiber wall thickness (EFWT)—a ratio of the net cross sectional area of the fiber to twice its width.

The changes in the thickness of the cell wall, the width-thickness ratio, and the roundness factor were determined from measurements on photomicrographs prepared by the following precedure. A random sample of 200 fibers over 3 mm. in length was selected from the semichemical pulp with the aid of a dissecting microscope. These fibers were randomly separated into two groups of 100 fibers each. One group was chlorited under conditions similar to the large-scale chloriting procedure of Graff and co-workers (*9*). If the semichemical fiber had a wall thickness greater than 5 mu, it was considered a summerwood fiber; if it was less than 5 mu, it was believed to be a springwood fiber. For the chlorited fiber, the dividing wall thickness was 4.5 mu. These criteria were selected arbitrarily after a visual examination of the photomicrographs. These data are presented in Table V.

Chloriting resulted in a decrease in the wall thickness of the fiber but this did not seem to affect its state of collapse. Although there was a slight tendency for the springwood fibers to become ribbonlike, an analysis of the width-thickness ratio and the roundness factor indicated that there seemed to be no significant collapsing of the lumen from the action of the chlorite. However, the lumen partially collapsed in most springwood fibers for all pulps. Therefore, the state of collapse of the fiber was not responsible for the different apparent densities and the different strength properties of paper from the pulps investigated in this study.

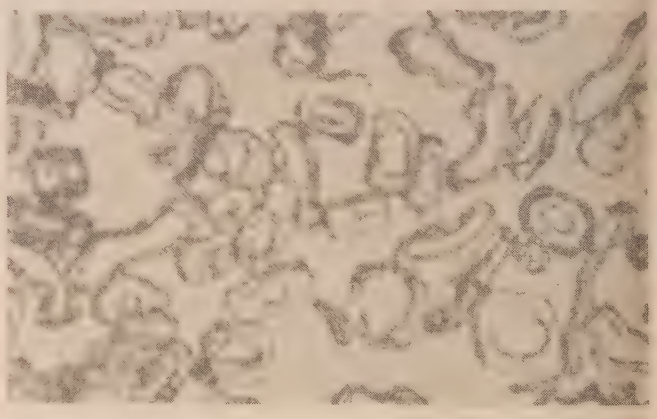

Fig. 1B. Semichemical cross sections (250×). Wet

A survey of the literature and a study of the relationships among the papermaking properties point strongly

to the swelling power of the pulp as a basic factor in the whole problem (*10*). Water-swollen fibers, beaten for various intervals, could not be cross sectioned without preliminary drying. However, the swelling power of the semichemical and the chlorited pulps was estimated by using the following procedure. A sample of long-fibered unbeaten semichemical pulp was imbedded in paraffin and cross sectioned as described previously. First, the group of cross sections were photographed in the dry state (Fig. 1A), and again after immersing the microscopic slide in water for 30 min. (Fig. 1B). The cross sections were subjected to one 15-min. treatment with acetic acid and sodium chlorite in the same proportions as used in the previous microchlorite treatment and then photographed. Another photomicrograph was taken of the chlorited cross sections in the dry condition. The photomicrographs of the chlorited fibers were not included because the changes in the fiber dimensions were not readily evident by a visual examination. Table VI presents the data on the change in the net area after swelling in water.

The chloriting of a semichemical fiber increased its degree of swelling in water. In their natural state, the lignin and the carbohydrate portions of the cell wall are saturated with water. It was shown that, when the water was removed, the fiber tended to shrink, but that the lignin seemed to prevent the cell wall from contracting as much as in a lignin-free fiber. On reswelling in water the fibers tended to return to their natural state, and there was almost no difference in the net cross-sectional areas of the water-swollen semichemical and chlorited fibers. One purpose of the beating operation is to swell the fibers even more than above by opening up their structures so that water can penetrate further into the fiber. It seems reasonable to believe that the presence of this network of nonswelling, nonelastic lignin would tend to prevent a further increase in swelling similar to its tendency to prevent shrinkage on drying. If a hypothesis such as this, although not directly substantiated by data, is true, it can help very much in explaining the beating difficulty and the relatively poor strength of the semichemical pulp compared with that of the chlorited pulp.

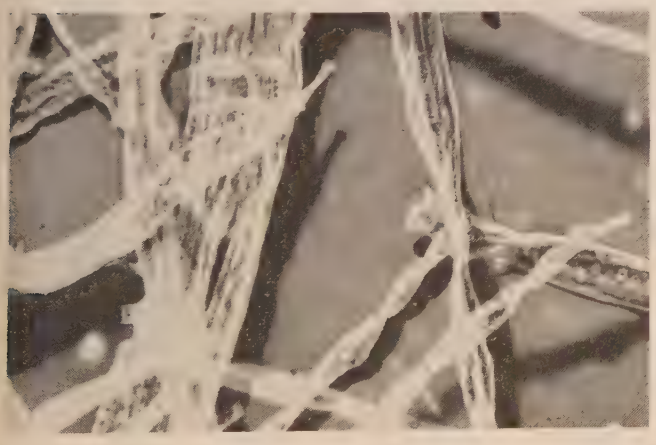

Fig. 2A. Semichemical pulp (100×). 0 hr.—S.-R. 895 ml.

Fig. 2B. Semichemical pulp (100×). 9 hr.—S.-R. 375 ml.

Table VI. Fiber Cross-Sectional Measurements

Property	Semichemical						Chlorited semichemical					
	Dry			Wet			Dry			Wet		
	Sp.	Su.	To.	Sp.	Su.	To.	Sp.	Su.	To.	Sp.	Su.	To.
Fibers measured	34	35	69	34	35	69	34	35	69	34	35	69
Net area, sq. mu	537	500	518	811	817	814	527	473	500	851	865	858
Std. dev.	19	33	19	26	59	31	19	30	19	32	59	34
				(dry basis)						(dry basis)		
Change in net area on swelling, %	...	...	...	54	64	59	...	...	...	65	81	73
Std. dev.	...	...	...	4	4	3	...	...	...	5	4	3

Sp.—springwood fibers.
Su.—summerwood fibers.
To.—total fibers (composite).
Std. dev.—standard deviation from the mean.

In the photomicrographs of Figs. 2 and 3, the effects of beating on the surfaces of the fibers are observed. These illustrations were prepared by a metal shadow casting technique developed by Williams and Wykcoff (*11*), and reviewed by Siegel (*12*). There seemed to be a very tough skin substance surrounding the semichemical fiber which prevented fibrillation in the early stages of the refining treatment (Figs. 2A and 2B). When the semichemical pulp was chlorited, the toughness of this skin substance must have been greatly reduced, for after a comparatively short beating time fibrillae appeared on the surfaces of the fibers (Figs. 3A and 3B). This fibrillation was very different from that of the semichemical pulp. Whereas the fibrillae of the latter existed as coarse, distinct threads emerging from the fiber surface, those of the chlorited pulp were generally too fine to be resolved at a magnification of 100 diameters. Once the surface of the chlorited fiber was broken open and some fibrillation had taken place, the entire fiber in that region seemed to split up into a mass of fibrillae. This phenomenon did not occur with the semichemical pulp. The importance of this fibrillation in the development of the strength of a pulp has never been completely determined, but it appears that a certain amount of fibrillation would be advantageous.

A group of cross sections of semichemical fibers were photographed at a magnification of 250 diameters before and after being subjected to a 15-min. treatment with 72% sulphuric acid as shown in Figs. 4A and 4B. A comparison of these two photomicrographs provided evidence of a certain distribution of lignin throughout the fiber.

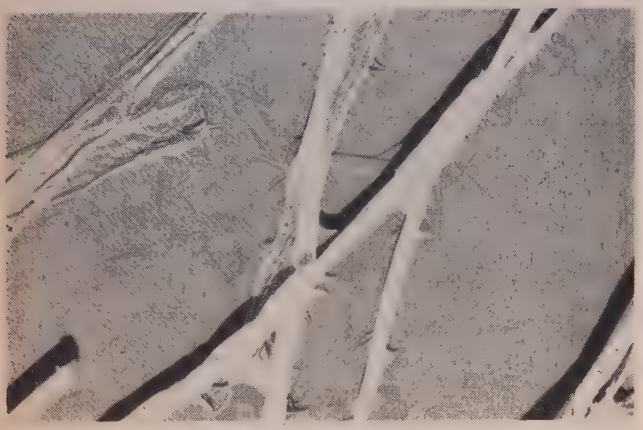

Fig. 3A. Chlorited semichemical pulp (100×). 0 hr.— S.-R. 860 ml.

Another experiment was carried out when it was observed that the lignin residue obtained from the semichemical fibers by 72% sulphuric acid had a fibrous structure. Some of these lignin fibers were photographed at a magnification of 100 diameters (Fig. 5). They definitely retained the over-all structure of the fiber, indicating that the lignin probably influences very significantly many properties of the fiber. After the lignin was dried, it was very brittle and crumbled when touched. An attempt was made to cross section this lignin residue (Fig. 6) but it was not very successful. However, on close inspection several cross sections can be seen in which there appeared to be a distribution of lignin across the fiber wall.

Zero-Span Tensile Strength

Several investigators have claimed that the zero-span tensile test gives a measure of the strength of the individual fibers in a sheet of paper. Therefore, this test was used to determine if there was any difference in the intrinsic fiber strengths of the semichemical and the chlorited semichemical pulps. In measuring this property of the pulp it is important to have a constant number of fibers per sheet cross section or, in other words, the same number of fibers between the jaws of the zero-span instrument. Institute of Paper Chemistry Method 527 was used in this determination. (Cf. TAPPI Suggested Method T 481 sm-52.) The zero-span tensile strengths on a constant fiber basis for both pulps at several degrees of beating are presented in Table VII.

There was no significant difference between the zero-span tensile strength of the semichemical and the chlorited pulps. This result agrees with a hypothesis presented by Hebbs (*13*) that the cellulosic portion of the fiber is the chief chemical component influencing the intrinsic strength of the fiber. In addition, beating had no effect on the zero-span tensile strength, which is in agreement with previous work (*14*). In this investigation the wet pressings given the sheets were varied and the fines were removed from the pulp, but these factors had no effect on the zero-span tensile strength. Therefore, this property was not responsible for the difference in the tensile and tearing strengths of the two pulps.

Table VII. The Effect of Beating on the Zero-Span Tensile Strength

Beating time, hr.	*Basis weight, g./sq. m.*	*Zero-span tensile strength,[a] lb.*
	Semichemical Pulp	
4.9	89.0	73.1
6.5	89.0	65.8
8.1	89.0	73.8
		$\sigma_{\bar{x}}$: 0.6–1.4
	Chlorited Semichemical Pulp	
0.8	66.0	69.3
1.6	66.0	74.4
2.4	66.0	72.0
		$\sigma_{\bar{x}}$: 0.5–1.1

[a] Average of ten determinations.

Clark (*14a*) has used the ratio of the normal tensile to the zero-span tensile strength as a measure of the degree of adhesion among the fibers. On a constant fiber basis and with similar solid fractions, an average degree of adhesion for the semichemical sheets was 38.0/69.2 or 0.55 as compared with 47.5/74.4 or 0.64 for the chlorited sheets. This indicated that the bonding properties of the chlorited pulp were better than those of the semichemical pulp.

Fiber Length

Clark (*15*) considers the weighted average fiber length the most useful measure of this property for determining relationships with the strength characteristics of the pulps. In this study the fiber lengths were measured by a projection method developed by Graff and Feavel (*16*). The data on the changes in the weighted average fiber lengths during the refining operation are presented in Table VIII.

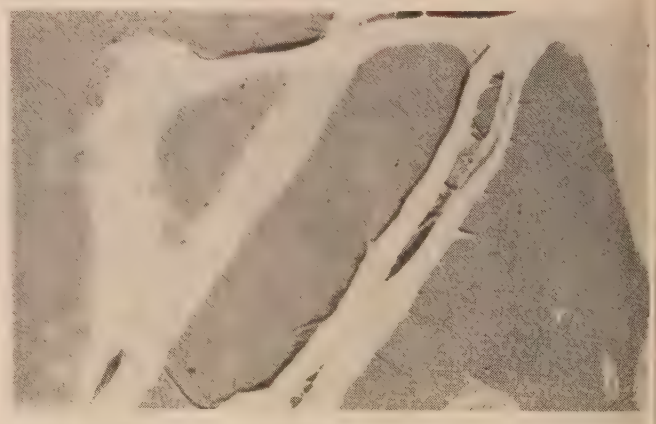

Fig. 3B. Chlorited semichemical pulp (100×). 3 hr.— S.-R. 370 ml.

The data indicated that, in the process of developing strength from the semichemical pulp by a pebble mill refining operation, the fiber length was considerably reduced but seemed to approach a constant value. The strength of the chlorited pulp was developed after a much shorter beating time, and there was no significant change in the fiber length.

In addition to its stiffening effect, the presence of the lignin in the semichemical pulp retarded its swelling in water and, thus, is probably responsible for the comparatively long refining time and the subsequent decrease in the fiber length of this pulp. The main effect of the fiber length on the tensile strength of paper seems to be due to the number of the fiber-to-fiber bonds that are associated with each fiber and also in the degree of cross linkage possibilities. In general, the longer the fibers, the greater are the potential bonding properties of the fiber. Therefore, a portion of the tensile strength, difference between the semichemical and the chlorited pulps can be accounted for by the decrease in the fiber length of the semichemical pulp. It is the general belief that a pulp with a higher weighted average fiber length produces a sheet with a higher tearing strength, other factors being equal. However, on a constant

Table VIII. The Effect of Beating on Fiber Length

Beating time, hr.	*Fibers measured*	*Weighted average, mm. Length*	*Std. dev.*
	Semichemical Pulp		
0	487	2.53	0.07
4.9	332	2.16	0.07
6.5	710	1.78	0.05
8.1	400	1.77	0.06
	Chlorited Semichemical Pulp		
0	325	2.64	0.08
0.8	371	2.53	0.07
1.6	299	2.75	0.08
2.4	279	2.58	0.07

Std. Dev.—standard deviation from the mean.

fiber basis the semichemical pulp produced a paper with a slightly larger tearing strength than that of the chlorited pulp. This anomalous behavior was probably due to a lower fiber-to-fiber bonding strength in the semichemical sheets.

Specific External Surface

The amount of exposed area available for bonding to other fibers is important in a study of the strength characteristics of a pulp. In this investigation this

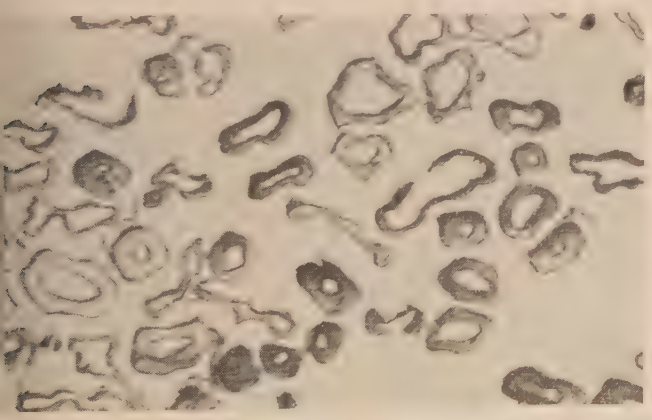

Fig. 4A. Semichemical cross sections (250×). Before 72% H_2SO_4

area was measured by the surface catalytic method described in TAPPI Standard T 226 sm. The data are presented in Table IX.

The importance of the fines in the measurement of specific surface can be easily observed from an inspection of Table IX. Much of the specific surface in the form of fines was lost during the formation of the handsheets, especially in the case of the semichemical pulp. Assuming no changes in the fiber surface area as a result of chloriting, the specific surface of the unbeaten chlorited pulp should be 1.35 times larger than that of the unbeaten semichemical pulp because of differences in yield. This was approximately true for the pulp that did not contain fines but not for the whole pulp.

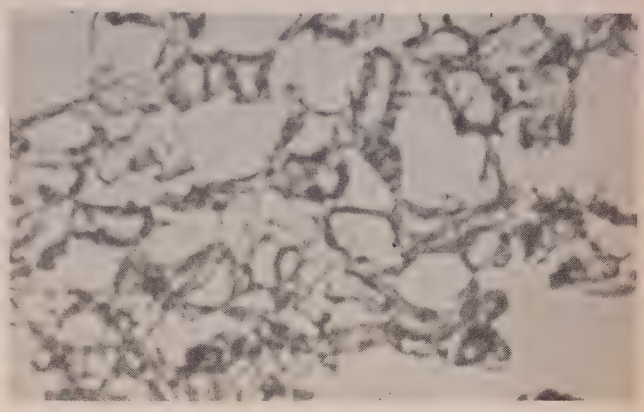

Fig. 4B. Semichemical cross sections (250×). After 72% H_2SO_4

In general, within each pulp the changes in specific surface correlated with the changes in the tensile strength resulting from beating or from a removal of the fines from the sheet. Baker and Browning (*17*) found a rough correlation between the increase of bursting strength and specific surface resulting from beating several species of unbleached kraft pulps. However, between these quantities for the two pulps used in this

Table IX. The Effect of Beating on the External Specific Surface

Units, Sq. Cm./G.

	Semichemical Pulp			
Beating time, hr.	0	4.9	6.5	8.1
Whole pulp	11,400	28,700	42,600	72,200
Pulp from standard sheet	...	15,500	20,100	25,200
Pulp with fines removed	8,700	10,200	11,400	12,800
	Chlorited Semichemical Pulp			
Beating time, hr.	0	0.8	1.6	2.4
Whole pulp	22,900	23,300	27,600	29,700
Pulp from standard sheet	...	15,800	17,400	19,500
Pulp with fines removed	12,500	13,400	13,200	14,100

work there was a negative correlation; the semichemical pulps had higher specific surfaces and lower tensile strengths than those of the chlorited pulps. In other words, on a constant fiber basis the semichemical pulp had a higher specific surface than that of the chlorited pulp even with the fines removed; thus, it also had more opportunity to bond. However, probably because of the nature of the lignified surface and the inherent stiffness of the fiber, the actual bonding forces among the fibers must have been less in the semichemical pulp than in the chlorited pulp in order for the latter to have had the higher tensile strength. Changes in specific surface, then, as measured by the surface catalytic method might be a satisfactory index of changes in strength

within a given pulp, but were not very useful in comparing pulps with widely different properties.

Bonded Area

In order to confirm the hypotheses already mentioned concerning the effect of the number of the fiber-to-fiber bonds on the strength characteristics of pulp, the fraction of the external surface area of the fibers that is in optical contact in a sheet was determined by a method developed by Parsons (*18*) and expanded by Ratliff (*2*). The unbonded sheets were made by first forming them from water, displacing the water with acetone, and the acetone with benzene. The data on the effect of beating on the bonded area are presented in Table X.

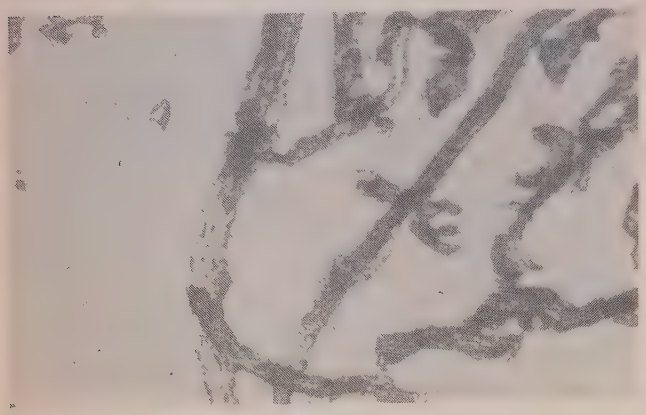

Fig. 5. Klason lignin from semichemical pulp (100×)

On converting the bonded area (sq. cm./g.) of the semichemical sheet to a constant fiber basis, the bonded area of this sheet was in one instance higher than that of the chlorited sheet, and yet the tensile strength of the former was lower. This can possibly be explained by a combination of two hypotheses: (1) the strength per unit bonded area of the semichemical sheet was much lower than that of the chlorited sheet and (2) a portion of the bonded area in each sheet was not involved in fiber-to-fiber bonding but in bonding among the fines. This latter type of bonding would be more prevalent in the semichemical pulp because of its higher content of fines.

The true fiber-to-fiber bonded area could not be determined since that proportion of the measured bonded area involved in fine-to-fine bonding was not known. It is believed, however, that the percentage of bonded area would be a more logical measure of the true fiber-to-fiber bonded area than the total bonded area for a comparison between sheets from two different pulps. The percentage bonded area within each pulp increased with an increase in the beating as indicated in Table X. By increasing the wet pressing from 50 to 400 p.s.i. on the semichemical and chlorited pulps refined at the median beating intervals, the percentage bonded area increased from 50.8 to 74.3% and from 83.3 to 89.1%, respectively. After removing the fines from these same pulps, the percentage bonded area decreased from 50.8 to 45.7% and from 83.3 to 77.2%, respectively. Since the bonding strength per unit of bonded area probably did not change significantly during these operations, the corresponding changes in the tensile strength were due mostly to these changes in the bonded areas of the sheets. The values of the percentage bonded area verified the conclusion drawn previously in regard to the changes in the tearing strengths of the pulps during beating, wet pressing, and the removal of fines. In all cases the increases in the bonded area were accompanied by decreases in the tearing strength.

The above discussion was concerned chiefly with comparisons within each pulp, whereby the bonding strength per unit of bonded area could be considered approximately constant. In comparing the strength characteristics between pulps, the effect of the percentage bonded area was modified by the differences in the unit bonding strength. However, it was noted that, in all instances, the percentage bonded area of the chlorited pulp was greater than that of the semichemical pulp. This was probably indicative of the greater flexibility of the chlorited pulp which permitted these fibers to be drawn closer together during the drying of the sheet so that larger fractions of the surface were in a position to be bonded.

Specific Bonding Strength

A method has been developed at The Institute of Paper Chemistry (*19*) which gives a measure of the bonding strength of paper. In this test a tensile stress is applied to the surface of the sheet by a film of viscous oil on a wheel which accelerates over the specimen. The applied stress is proportional to the velocity of the wheel and the viscosity of the oil and is called the viscosity-velocity product (VVP). From visual observations of the rupture it seemed that only bonds and not fibers were broken during the test. It is believed that the division of the VVP by the percentage bonded area will give a measure of the bonding strength per unit of bonded area. This ratio was called the specific bonding strength. In Table XI the data on the effect of beating on the bonding strength (VVP) and the specific bonding strength are presented. Two types of failure were recorded: (1) the first appearance of blisters from internal failure and (2) the first separation of the fiber from the body stock. The values marked "greater than" indicated that a failure could not be produced under the test conditions available.

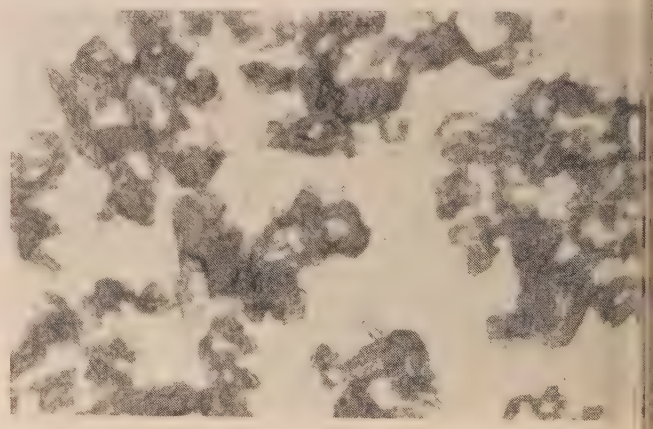

Fig. 6. Cross sections of Klason lignin from semichemical pulp (250×)

The data indicated that the specific bonding strength was dependent upon beating and was also dependent upon wet pressing and the content of fines in the sheet

Table X. The Effect of Beating on the Bonded Area

Beating time, hr.	Basis weight, g./sq. m.	Specific scattering coefficient,[a] sq. cm./g. Water sheet	Specific scattering coefficient,[a] sq. cm./g. Benzene sheet	Bonded area % of total area	Bonded area sq. cm./g.	Total surface area, sq. cm./g.
			Semichemical Pulp			
4.9	67.0	212	360	41.2	6,380	15,500
6.5	67.3	233	474	50.8	10,200	20,100
8.1	67.7	225	548	59.0	14,900	25,200
		$\sigma_{\bar{x}}$: 1-3	$\sigma_{\bar{x}}$: 2-8			
			Chlorited Semichemical Pulp			
0.8	72.6	111	459	75.8	12,000	15,800
1.6	70.0	92	551	83.3	14,500	17,400
2.4	70.7	68	599	88.7	17,300	19,500
		$\sigma_{\bar{x}}$: 1	$\sigma_{\bar{x}}$: 3-8			

[a] Average of ten determinations.

By increasing the wet pressing on the semichemical and chlorited pulps refined at the median beating intervals from 50 to 400 p.s.i., the specific bonding strengths for rupture increased from 967 to 1890 kp.-cm. per sec. and from 1970 to >2700 kp.-cm. per sec., respectively. After removing the fines from the same pulps, the specific bonding strengths decreased from 967 to 620 kp.-cm. per sec. and from 1970 to 1160 kp.-cm. per sec., respectively. The measurement of specific bonding strength not only included a measure of the true bonding strength per unit bonded area but also measure of the distribution of the stress among the fiber-to-fiber bonds. It was probable that much of the variation in the specific bonding strength within each pulp was due to differences in the stress distribution among the bonds.

The specific bonding strengths of the semichemical pulp were generally lower than those of the chlorited pulp. This was probably due to the deleterious effect of the lignin on the surface of the fiber. Lignin has a smaller percentage of hydroxyl groups than any carbohydrate material; thus, the lignin-lignin or the lignin-carbohydrate secondary bonds between the semichemical fibers were probably not as strong as the carbohydrate-carbohydrate secondary bonds between the chlorited fibers.

The effect of the specific bonding strength and the effect of the bonded area on the tensile strength and on the tearing strength due to chloriting were synergistic. Together they were partly responsible for the increase in the tensile strength of the semichemical pulp after chloriting by forming more and stronger bonds between the fibers. The higher bonding strength was also responsible for counteracting the effect of the longer fiber length of the chlorited pulp in producing a sheet with a slightly lower tearing strength than that from the semichemical sheet on a constant fiber basis. And, finally, by means of this higher bonding strength combined with higher fiber flexibility, chlorited sheets were produced that had higher solid fractions than could be obtained under normal wet pressures from the semichemical pulp.

Table XI. The Effect of Beating on the Specific Bonding Strength

Beating time, hr.	Bonding strength,[a] kp.-cm./sec. Wire side Blister	Bonding strength,[a] kp.-cm./sec. Wire side Tear	Specific bonding strength, kp.-cm./sec. Wire side Blister	Specific bonding strength, kp.-cm./sec. Wire side Tear
		Semichemical Pulp		
4.9	118	306	300	776
6.5	213	466	442	967
8.1	545	890	910	1480
		Chlorited Semichemical Pulp		
0.8	484	905	627	1170
1.6	709	1630	855	1970
2.4	>1770	>1770	>2000	>2000

[a] Average of four determinations.

CONCLUSIONS

1. On a constant weight basis the tensile strength of the semichemical pulp was lower than that of the chemical pulp because the chemical sheet had more fibers per sheet cross section than did the semichemical sheets. When this factor was constant, the tensile strengths were approximately equal.

2. On a constant weight basis, the tensile strength of the semichemical pulp was lower than that of the chlorited semichemical pulp because: (1) the chlorited sheets had more fibers per sheet cross section among which to distribute the load; (2) the flexibility and the degree of swelling of the chlorited fibers were higher which allowed these fibers to have greater opportunities for fiber-to-fiber bonding; (3) the weighted average fiber length of the chlorited pulp was higher; and (4) the surface properties of the chlorited fibers were such as to produce sheets with a higher percentage bonded area and a higher specific bonding strength.

3. On a constant weight basis, the tearing strength of the chlorited pulp was higher than that of the semichemical pulp because, in the sheets produced from the former pulp, there were more fibers participating in the tearing action at the zone of rupture. On a constant fiber basis the tearing strength of the semichemical pulp was slightly higher than that of the chlorited pulp because of the greater fiber-to-fiber bonding forces of the chlorited pulp.

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Intensity of the Odor Release at Various Points in the Kraft Pulping Process

M. A. SCHOENING and R. H. WRIGHT

Measurements are reported of the concentration of hydrogen sulphide and methyl mercaptan in various effluents from a sulphate mill.

THE problem of odor control in the kraft process is complicated by the fact that malodorous materials are liberated in varying amounts at many different points in the plant. Many otherwise excellent measures to reduce the odor have failed to eliminate the nuisance because they have left untouched one or more important sources (*1*, *2*). With the notable exception of Reid's paper (*3*), little systematic information appears to have been published on the quantities of malodorous material in the various effluents.

During a study of the problem of odor reduction, a survey was carried out at the Bloedel, Stewart, and Welch pulp mill at Port Alberni, B. C. This survey covered the concentration of hydrogen sulphide and of methyl mercaptan in various effluents. This mill opened in 1947 and has been described elsewhere (*4*).

SAMPLING PROGRAM AND METHODS

The analytical method used in the survey has been previously described (*5*). A number of minor modifications were introduced at various stages in the survey. Thus, in sampling furnace and stack gases containing a high proportion of CO_2, it was necessary to increase the concentration of the NaOH solution used for absorbing the gases from $N/5$ to $3N$. This did not appear to impair or alter the test results. Where the gas being tested carried a negligible amount of condensable material (as for example at the roof ventilators or the sewer outfall), the gas sample was collected by a tube and funnel and drawn directly through the absorbing solution into the measuring syringe. Where the gas contained large quantities of condensable material (blow gases, furnace gases, etc.) the sample was passed first through a condenser and then into a trap, see Fig. 1. The noncondensable gases were then passed through the absorbing apparatus in the usual way and a sample of the condensate was transferred to a sealed vial by means of a hypodermic syringe. Where necessary suction was used to draw the gases through the apparatus.

The interval between taking a sample and beginning the colorimetric analysis was always less than 1 hr. and usually not more than 20 min.

Samples were collected for analysis at the following points:

Digester Relief and Gas-off. Samples of noncondensable gases and of condensate were obtained from a valve installed in the relief line about 3 ft. from the top of no. 2 digester.

Blow Gases. At Port Alberni the blow tank is located outside the digester building. At the time of the survey it was not provided with a cyclone or heat recovery system, and the steam and other gases were vented directly to the atmosphere producing a plume as shown in Fig. 3. Samples were withdrawn through a length of $^1/_2$-in. pipe welded into the side of the vent pipe about 3 ft. above its junction with the body of the tank. Noncondensable gases and condensate were analyzed separately.

Evaporator Effluents. The effluent from the multiple-effect evaporator was sampled after leaving the barometric leg of the jet condenser. Owing to operating difficulties due to incomplete separation of gases from the condensate, the separate exit pipe for noncondensable gases from the seal-pot of the barometric condenser had been blanked off, and condensate and noncondensable gases were discharged together through a single pipe into a weir outside the building. During the survey, therefore, both liquid and gas were sampled in the concrete tank into which the seal-pot emptied. There was no difficulty in obtaining representative samples of the liquid, but the gas samples had to be taken in the space immediately above the liquid surface where the noncondensable gases were necessarily heavily diluted with air.

Furnace Gases. Flue gases were regularly sampled for standard Orsat analysis at a station near the top of the recovery furnace. The same sampling pipe was used for taking samples for this investigation. The standard condenser-trap assembly shown in Fig. 1 was used with the addition of a horsehair filter to remove soot and chemical fumes from the gases before they entered the condenser.

Stack Gases. Furnace gases after passing through a cascade evaporator and electrostatic precipitator, enter the main stack through a horizontal duct. An opening in the top of the duct gave access to the interior about 7 ft. from the dampers. The flow of flue gas through the duct was not uniform, being practically stagnant near the top. Samples were therefore taken at various depths using a pipe terminating in a filter assembly with a paper thimble to remove the dust and fumes.

Washer Room Ventilators. Steam and gases from the knotter and pulp washers are collected by hoods and discharged to the atmosphere through a series of four vents on the roof. Samples were taken from the vent openings.

Green Liquor Tank Vapors. The steam from the

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green liquor tank in which the smelt is dissolved is vented directly to the atmosphere through a muffler on the roof. The issuing vapor was sampled.

Sewer Outfall. The sewer outfall from the plant is located at the head of a marshy area adjacent to the

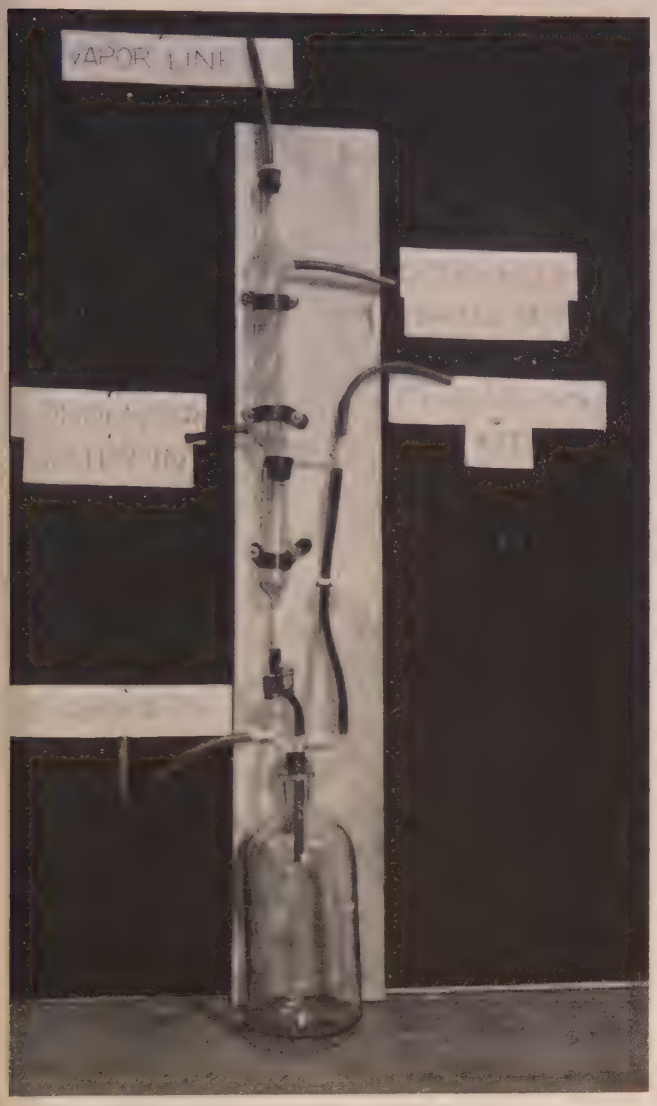

Fig. 1

Alberni Inlet. The outfall is practically at ground level and samples of the liquid and the air immediately above the surface were readily obtained.

Lime Sludge Filter. Since there was a perceptible amount of odor in the vicinity of the lime sludge filter which was washed with contaminated hot water, air samples were collected for analysis in the hood over the filter.

An extensive exploration of the plant showed that the foregoing were the principal points of odor release. During the time the survey was in progress, the weather conditions generally favored rapid dissipation of the gaseous effluents in the upper air. There was therefore very little odor in the surrounding built-up areas and no measurements were made at a distance from the mill.

The survey was carried out between May 3 and June 23, 1950. During May, the operating procedure of the mill included the addition of 200 lb. of elementary sulphur to each digester charge. At the end of May this practice was discontinued and the white liquor sulphidity fell rapidly as can be seen from Fig. 2 which is plotted from the mill operating records.

The principal wood species cooked were western hemlock and Douglas-fir with lesser amounts of western red cedar. The various species were cooked separately and an attempt was made to measure the concentration of malodorous gas originating from digester charges of each species.

EXPERIMENTAL RESULTS

Digester Gas-Off

Following the charging of a digester, permanent gases are released from time to time during the early stages of the cook. The gases so removed are referred to as the "gas-off." At the end of the cook the pressure in the digester is reduced to something under 100 lb. before blowing the charge. The gases released at this stage are called "relief-gases."

Table I shows the results of analysis of gas-off samples, both condensable and noncondensable, from several cooks and at various intervals after charging the digester.

In general, the cooking procedure at Port Alberni called for the interventing of relief gases into newly charged digesters. This may account for the high initial concentration of malodorous substances found in the gas-off from certain cooks and the much lower values in others. In the absence of such a procedure one would expect a low initial concentration with a rapid increase at some definite pressure. Suttermeister (*6*) suggests that mercaptans and sulphides begin to form at between 40 and 60 p.s.i. From observations of the variation of pressure with time during a typical cook one would expect the concentration of malodorous

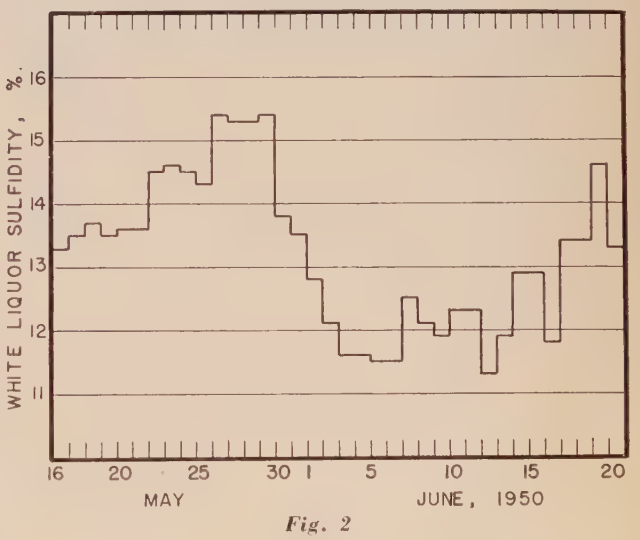

Fig. 2

material to show a significant rise 30 to 40 min. after the beginning of the cook.

Although no data were obtained on the proportion of condensable gases in the gas-off vapors, experience suggested that this ratio would be greater than 98%.

Table I. Digester Gas-Off

Chips	Digester	Sample taken	Noncondensable gas H_2S, μg./l.	Noncondensable gas MeSH, μg./l.	Condensate H_2S, μg./ml.	Condensate MeSH, μg./ml.	Remarks
Fir	10:54	11:12–11:18	104	13,600	18	304	Digester charge included 200 lb. sulphur
		11:18–11:26	96	14,600	19	64	
		11:26–11:35	112	6,300	14	32	
Hemlock	9:15	9:50– 9:53	192	6,000	32	224	Digester charge included 200 lb. sulphur
		9:53– 9:58	40	9,800	41	176	
		9:58–10:03	120	7,300	38	144	
Fir	11:52	12:10–12:13	...	...	..	...	No sulphur added to digester charge
		12:13–12:16	...	...	1	...	
		12:16–12:21	...	920	1	...	
		12:21–12:27	...	280	3	...	
		12:27–12:34	16	1,240	6	...	
		12:34–12:42	...	1,040	7	...	
Hemlock	10:46	10:53–10:58	...	120	9	...	
		10:58–11:04	...	1,000	8	...	No sulphur added to digester charge
		11:04–11:10	...	440	..	...	
		11:10–11:17	...	400	..	...	
		11:17–11:23	8	1,230	2	...	
		11:23–11:29	...	...	4	...	

On the basis of this value, the nuisance arising from the gas-off vapors was probably of minor importance as compared with the relief and blow gases described more fully below.

It should be noted that the formation of malodorous materials was reduced by approximately 90% when sulphur was omitted from the digester charge.

Digester Relief Gases

The results shown in Table II show a satisfactory consistency of mercaptan concentration in the noncondensable gases. Rather surprisingly, the omission of elementary sulphur from the cooking cycle made very little difference to the mercaptan concentration in the noncondensable gas although it did give a considerable reduction in the concentration of both malodorous materials in the condensate. The results indicate that a higher concentration of mercaptan is given off in the noncondensable gas from a fir cook than from a hemlock cook. It is possible that this variation was connected with the formation of turpentine and other oils from fir. These relatively volatile reaction products might be expected to carry with them a higher concentration of organic sulphides.

Digester Blow Gases

These gases were extensively investigated with the results shown in Table III.

The noncondensable gases showed large variations in composition. The cause of this variation was not fully established but there were indications that it might have been connected with variations in the blowing pressure.

In an attempt to smooth out the irregularities, the mercaptan concentrations found in the condensable and noncondensable fractions were combined to give a figure for the concentration in the blow tank vapor. This involved a knowledge of the relative amounts of condensable and noncondensable material. Samples were sucked out of the blow tank vent pipe by means of an aspirator and measurements were made of the volume of gas collected in the aspirator bottle and the volume of condensate collected in the trap. The ratio was found to be very close to 0.04 ml. of condensate per ml. of noncondensable gas measured at atmospheric temperature and pressure (approximately 25°C.). Using this ratio and assuming the condensate to be practically pure water, the volume of water vapor and noncondensable gas at 100°C. and 1 atm. was calculated and the concentration of MeSH derived from both condensable and noncondensable fractions was estimated. The result is given in the last column of Table III as micrograms per liter of blow gas vapor at 100°C. and 1 atm. pressure. This had the effect of materially reducing the amount of variation between the different experiments. On at least one occasion when an unusually high concentration of malodorous material was found, the digester was blown at an unusually high pressure because of a plugged screen.

Apart from the effect of the digester pressure at the

Table II. Digester Relief

Chips	Digester filled	Digester relieved	Digester blown	Sample taken	Noncondensable gas H_2S, μg./l.	Noncondensable gas MeSH, μg./l.	Condensate H_2S, μg./ml.	Condensate MeSH, μg./ml.	Remarks
Fir	7:50	10:23	10:50	10:27–10:30	60	18,300	108	1308	Digester charge included 200 lb. sulphur
				10:32–10:35	76	19,800	140	812	
				10:36–10:39	104	20,400	151	816	
Hemlock	7:45	11:00	11:19	11:03–11:06	16	13,400	166	1170	Digester charge included 200 lb. sulphur
				11:06–11:13	32	14,700	165	916	
				11:13–11:19	64	13,500	124	760	
Fir	11:42	4:27	4:51	4:33– 4:37	160	17,300	73	178	No sulphur added to digester charge
				4:37– 4:42	93	17,500	49	136	
				4:42– 4:47	147	20,800	48	128	
				4:47 – 4:51	73	19,500	56	140	
Hemlock	6:41	9:20	9:41	9:26– 9:29	84	15,200	16	456	No sulphur added to digester charge
				9:29– 9:32	104	14,600	22	444	
				9:32– 9:35	124	13,500	42	436	
				9:35– 9:38	32	12,000	43	244	
				9:38– 9:41	72	14,000	71	312	

Table III. Digester Blow Gases

Chips	Digester blown	Sample taken	Noncondensable gas H_2S, µg./l.	Noncondensable gas MeSH, µg./l.	Condensate H_2S, µg./ml.	Condensate MeSH, µg./ml.	Total vapor MeSH, µg./l. at 100°C.	Remarks
Fir	1:45	1:47 – 1:49	n.d.	12,500	n.d.	n.d.	n.d.	Digester charge included 200 lb. sulphur
		1:49 – 1:50	n.d.	31,700	n.d.	n.d.	n.d.	
		1:50 – 1:52	n.d.	49,000	n.d.	n.d.	n.d.	
		1:52 – 1:52½	n.d.	93,100	n.d.	n.d.	n.d.	
		1:52½ – 1:53½	n.d.	99,900	n.d.	n.d.	n.d.	
		1:53½ – 1:55	n.d.	102,700	n.d.	n.d.	n.d.	
		1:55 – 1:57	n.d.	51,400	n.d.	n.d.	n.d.	
Fir	9:30	9:31 – 9:33	n.d.	5,680	n.d.	n.d.	n.d.	Digester charge included 200 lb. sulphur
		9:33 – 9:35	n.d.	11,400	n.d.	n.d.	n.d.	
		9:35 – 9:36½	n.d.	12,800	n.d.	n.d.	n.d.	
		9:36½ – 9:38	n.d.	16,800	n.d.	n.d.	n.d.	
		9:38 – 9:40	n.d.	23,200	n.d.	n.d.	n.d.	
		9:40 – 9:42	n.d.	19,200	n.d.	n.d.	n.d.	
		9:42 – 9:43½	n.d.	30,000	n.d.	n.d.	n.d.	
		9:43½ – 9:45	n.d.	22,000	n.d.	n.d.	n.d.	
Hemlock	9:52	9–53 – 9:55	n.d.	11,200	n.d.	n.d.	n.d.	Digester charge included 200 lb. sulphur
		9:55 – 9:57	n.d.	33,600	n.d.	n.d.	n.d.	
		9:59 –10:00	n.d.	36,400	n.d.	n.d.	n.d.	
		10:00 –10:01	n.d.	49,800	n.d.	n.d.	n.d.	
		10:01 –10:02	n.d.	29,600	n.d.	n.d.	n.d.	
		10:02 –10:03	n.d.	38,400	n.d.	n.d.	n.d.	
		10:03 –10:05	n.d.	16,800	n.d.	n.d.	n.d.	
Fir	9:09	9:10 – 9:14	...	4,600	13	188	198	No sulphur added to digester charge
		9:14 – 9:18	...	3,800	28	356	281	
		9:18 – 9:23	...	19,800	20	344	578	
Fir	1:10	1:10 – 1:14	...	3,800	16	228	206	No sulphur added to digester charge (blown from higher than usual pressure)
		1:14 – 1:18	...	8,800	34	428	424	
		1:18 – 1:22	80	30,800	29	524	892	
Hemlock	10:37	10:37 –10:42	...	800	2	120	85	No sulphur added to digester charge
		10:42 –10:46	...	6,200	12	188	228	
		10:46 –10:50	...	3,300	21	356	272	
Hemlock	3:34	2:35 – 2:40	...	6,600	22	112	191	No sulphur added to digester charge
		2:40 – 2:44	...	10,400	31	212	322	
		2:44 – 2:47	...	11,700	1	8	227	

n.d.—not determined.

time of blowing, there are indications that Douglas-fir yields a higher concentration of malodorous material than hemlock. The use of raw sulphur in the digester charge results in a two to threefold increase in the mercaptan concentration of the noncondensable gases. The results indicate a general increase in the concentration of malodorous material as the blow progressed. This may have been due in part to a dilution of the gases by air drawn into the tank during the period between blows.

It is clear from the results that the blow tank vapors are a major source of odor particularly when, as was formerly the case at Port Alberni, no attempt is made to condense the steam. The total volume of gases emitted from the blow tank vent pipe could not be measured because the quantity of pulp which was entrained in the gases would have rapidly plugged any Velometer or Pitot tubes with which the gas velocity might otherwise have been measured. A very rough approximation to the total volume of steam flashed off during the blowing of the digester was calculated. The resulting figure of 16,400 lb. when combined with the ratio of condensable to noncondensable gases given above, indicated that the noncondensable blow gases would occupy approximately 6400 cu. ft. at atmosphere pressure and temperature.

Table IV. Evaporator Jet Condenser Effluent

Date	Liquid effluent H_2S, µg./ml.	Liquid effluent MeSH, µg./ml.	Air above liquid surface H_2S, µg./l.	Air above liquid surface MeSH, µg./l.
May 25, 1950	2	24	Tr.	120
May 30, 1950	Tr.	12	...	28
May 31, 1950	Tr.	Tr.	...	20
June 2, 1950	Tr.	Tr.	Tr.	16

On the basis of the calculated volumes of steam and noncondensable gas, the loss of sulphur through the blow tank was also estimated. The total mercaptan in the noncondensable gas worked out at about 20 lb. In the condensable fraction, the mercaptan amounted to approximately 13 lb. and the hydrogen sulphide to about 1.6 lb. The total loss expressed as sulphur was of the order of 22 lb. per cook.

It is apparent that the blow gases are a major source of odor release.

Evaporator Effluents

Although, as will be seen from Table IV, both hydrogen sulphide and methyl mercaptan were found in the effluent from the barometric condenser, their relatively low concentration in both the condensable and noncondensable fractions reduced the order of their importance in the over-all picture. Since the temperature of the liquid leaving the barometric leg was only slightly above the ambient temperature, it followed that very little vapor was released from it to the atmosphere. Thus the contribution of this effluent to the general

Table V. Furnace Gas

Date	Noncondensable gas H_2S, µg./l.	Noncondensable gas MeSH, µg./l.	Condensate H_2S, µg./ml.	Condensate MeSH, µg./ml.
May 27, 1950	...	7	2	40
May 29, 1950	390	..	49	56
May 30, 1950	84	..	52	112
June 1, 1950	52	..	10	40
June 9, 1950	1	..	3	4
June 12, 1950	2	..	2	10
June 15, 1950	3	..	9	78
June 20, 1950	...	..	27	24

odor release would appear to have been relatively insignificant. This conclusion while probably correct so far as Port Alberni was concerned might not be valid in another mill operating at a higher sulphidity.

Furnace Gases

Routine mill analyses showed that the furnace gases normally carried about 17% CO_2. Since this would be absorbed by the sodium hydroxide in the absorption

Fig. 3

vial, the volume of gas drawn into the syringe was corrected for the amount of CO_2 lost in passing through the alkaline absorbing solution. The results shown in Table V include this correction.

It will be seen that there is a certain amount of rather erratic variation in the figures obtained. The mill operating records were searched for a clue to the cause of these variations but without success. Apart from the erratic changes, a trend can be observed paralleling the marked drop in sulphidity that took place at the end of May when the addition of sulphur to each digester charge was discontinued.

The general conclusion that may be drawn from these results is that the furnace gases did not constitute a high intensity source of odor under the conditions existing at Port Alberni, particularly when the sulphidity fell to a low value as it did after June 1.

Stack Gases

The same correction for the CO_2 content of the noncondensable gases was made at the stack station as was made at the Orsat station. This involved the assumption that the leakage of air into the ducts, the cascade evaporator, and the electrostatic precipitator was negligible and that there was a negligible liberation of noncondensable gases in the cascade. While these assumptions were not altogether justified, the error would not be large. In the absence of Orsat analyses of the stack gases it seemed better to apply the full correction than to omit it altogether.

The stack gas analyses are shown in Table VI. Comparison with values found at the Orsat sampling station on corresponding dates shows that there was an appreciable pickup of malodorous material in the cascade evaporator.

Table VI. Stack Gas

Date	*Noncondensable gas depth 6 ft.* H_2S, μg./l.	*MeSH*, μg./l.	*Noncondensable gas, depth 12 ft.* H_2S, μg./l.	*MeSH*, μg./l.	*Condensate combined, 6 and 12 ft.* H_2S, μg./ml.	*MeSH* μg./ml.
June 9, 1950	3	..	42	..	1	..
June 9, 1950	326	..	195	..	7	30
June 12, 1950	119	..	204	..	5	10
June 15, 1950	370	..	536	36	15	25
June 20, 1950	460	15	420	..	46	28

From mill records the gas flow through the duct was known to be about 37,500 c.f.m. under standard conditions. Putting the hydrogen sulphide content of the stack gas at 200 μg. per liter, this corresponded to an output of 213 grams of hydrogen sulphide per min. or approximately $^1/_2$ lb. per min. A comparison of the mercaptan content of the stack gas with its concentration in the noncondensable blow tank gases shows that the stack gases carried about one third as much odorous material as the noncondensable blow gases and at a much lower concentration.

Washer Room Ventilator

The results shown in Table VII indicate that the nuisance from this source is negligible. Detectable

Table VII. Miscellaneous

Sampling	*Date*	*Noncondensable gas* H_2S, μg./l.	*MeSH*, μg./l.	*Liquid* H_2S, μg./ml.	*MeSH*, μg./ml.
Roof vent over knotter	May 10, 1950	...	32	..	..
	May 24, 1950	...	20	..	..
	May 30, 1950	...	4	..	..
Roof vent over green liquor smelt tank	May 18, 1950	...	..	..	..
	May 30, 1950	...	..	..	..
Hood over lime sludge filter	June 1, 1950	...	16	..	..
Sewer outfall	May 18, 1950	...	..	..	..
	May 26, 1950	Tr.	..	2	12
	May 31, 1950	Tr.	Tr.	..	10

amounts of mercaptan were found only at the ventilator immediately above the knotter. The analytical method had to be pushed to the limit to secure even this indication.

Green Liquor Tank Vapors

Table VII shows that no detectable amounts of either hydrogen sulphide or methyl mercaptan could be found in these gases.

Sewer Outfall

As can be seen from Table VII the sewer outfall provided a low intensity source of odor. Under existing conditions this can probably be considered insignificant but the situation might be expected to alter under certain circumstances, as for example if the installation of a blow heat recovery system resulted in the discharge of large quantities of contaminated condensate.

Lime Sludge Filter

The analyses shown in Table VII confirm the direct

perception of smell at the lime sludge filter but suggest that the over-all contribution to the nuisance is not important.

SUMMARY

Under the operating conditions existing at Port Alberni at the time of the survey, the blow tank and stack gases were the primary sources of odor. The other effluents were distinctly minor in comparison with these.

The highest concentrations of methyl mercaptan were found in the noncondensable blow gases which occasionally showed 100,000 μg. per liter. This was a peak value and there was a considerable amount of rather erratic variation possibly due to variations in the blowing pressure and other causes.

When the digester charge included 200 lb. of elemental sulphur, the release of malodorous substances in the noncondensable gases was increased approximately threefold.

There are indications that slightly more odor is given off from a cook of Douglas-fir than from a cook of hemlock.

It was not possible to measure the total volume of condensable and noncondensable gases released from the blow tank but a rough calculation suggested that the loss of sulphur from the blow tank may have exceeded 20 lb. per cook.

Under the conditions existing during the survey, the furnace gases carried only small amounts of mercaptan and hydrogen sulphide. During their passage through the cascade evaporator there was an appreciable pickup of malodorous material which escaped to the atmosphere through the stack. On the basis of estimates of the total volume of stack gas, the magnitude of the nuisance from the stack appeared to be secondary to that from the blow tank.

With the low sulphidity cooking liquor in use at the time of the survey the effluents from the multiple-effect evaporator constituted only a minor source of nuisance in comparison with the blow tank and stack.

Other sources of odor were essentially negligible.

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Design Basis for Ammonia-Base Sulphite Raw-Acid Towers

ROY P. WHITNEY and S. T. HAN

Current interest in the ammonia-base sulphite process has directed attention to the preparation of the raw cooking acid. Since the ammonia-base system has certain unique features, with respect to the other bases, the acid-making equipment must be designed and must function accordingly. The factors which are important in the design of a raw-acid tower are considered in some detail, and an accumulation of the best available design data for this system is presented. These data are derived in part from the literature and in part from previously unpublished work. The data and techniques presented are then used in an illustrative problem involving a raw-acid tower design for a set of typical operating conditions. The conversion of existing equipment to ammonia-base operation is also considered.

The ammonia-base sulphite pulping process is one of considerable current interest. Several plants are operating on the ammonia-base process, and it is probable that others will follow. Plant conversion from calcium to ammonia base does not require extensive equipment alteration, but one point which warrants consideration is the preparation of the raw cooking acid. The equipment used for this purpose in many calcium-base plants is not well suited for preparing ammonia-base acid.

Raw-acid preparation is largely an absorption operation. Calcium-base acid is commonly prepared in two large towers packed with solid limestone, over which water and sulphur burner gas are contacted countercurrently. The limestone packing steadily dissolves in the acid and is periodically replaced. Ammonia-base acid should also be prepared in a countercurrent packed tower, but the packing in this case is inert to the system. Because of the absence of solid phases, the kinetic considerations are quite different and the tower and packing characteristics should be chosen accordingly.

The operation of a packed absorption tower can best be analyzed and understood in terms of the two-film theory. While there are indications that this theory may give way to some better approach in the future, there is presently no alternative adequately developed for design purposes. The film theory is extensively covered in textbooks (*1*), and has been discussed by various authors (*2*, *3*). It will be employed quantitatively below.

Absorption towers, like most industrial equipment, should be designed on the basis of economic balances

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to evolve an over-all minimum equipment and operating cost. However, the operation of acid making is dictated more by the requirements of the pulping process than by the absorption itself, and many of the design variables which normally control the optimum conditions in absorption are in this case fixed. The problem is still largely economic, however, in that the object is to design equipment which will function smoothly and efficiently to provide the required raw acid at the minimum total cost; gross overdesign, with its attendant high initial and maintenance costs, is to be avoided.

MAJOR DESIGN VARIABLES

In the design of an absorption system, the major variables to be considered are: (1) the stoichiometry of the system, (2) the thermal effects attending the operation, (3) the equilibrium solubility relation, (4) the choice of packing material, (5) the liquor and gas rates, (6) the cross-sectional area of the tower, and (7) the height of the packed section. It is proposed to discuss each of these factors for the case at hand, presenting in each instance the best available design data and information. In some cases the data have been gathered from the literature, and in others they have not been previously published. The accumulated data will then be used to solve a typical design problem.

Stoichiometry

The stoichiometric, or material balance, relations for this case are fixed by the raw-acid requirements. The quantity of raw acid and its combined and total sulphur dioxide contents* are determined by the pulping schedule and by the quantity of sulphur dioxide reclaimed from the digesters. These also fix the ammonia requirement and the demand for sulphur dioxide in the burner gas. Since the burner gas strength is also fixed within narrow limits by burner operation, the complete material balance over the absorber is easily calculated and, more important, is beyond the control of the designer. (It is evident that, were this material balance incompatible with the solubility relationship, process modifications would be necessary.)

Thermal Effects

The temperature at which an absorption operation is conducted usually has a major effect on performance. In this system, the most important effect of temperature is on the solubility relation; the lower the temperature, the stronger is the acid which can be produced, or the smaller is the necessary packed height for a given acid strength. The burner gas entering the absorber should be as cool and as dry as possible, and the water used for acid preparation should be the coolest available. (The effects of temperature on the absorption coefficients will be mentioned later.)

The temperature of the raw acid leaving the absorber should always be calculated by means of a heat balance. Such a balance will demonstrate the very important effect of the heat of dilution of the concentrated ammonia solution fed to the tower, the heat of reaction of the ammonium hydroxide and sulphur dioxide, and the heat of solution of the sulphur dioxide gas. These three phenomena are all exothermic, and they may, in a typical case, bring about a temperature rise of as much as 25°F. in the liquor passing through the tower. During the summer months, such a temperature rise may decrease the solubility to such an extent as to make it impossible to produce raw acid of the desired strength, without recourse to water cooling or cooling of the raw acid during its preparation. Often well water is available in sufficient quantity for this purpose, and in rare instances pressure operation is justified.

Table I lists the necessary heats of formation, solution, and dilution from which these thermal effects

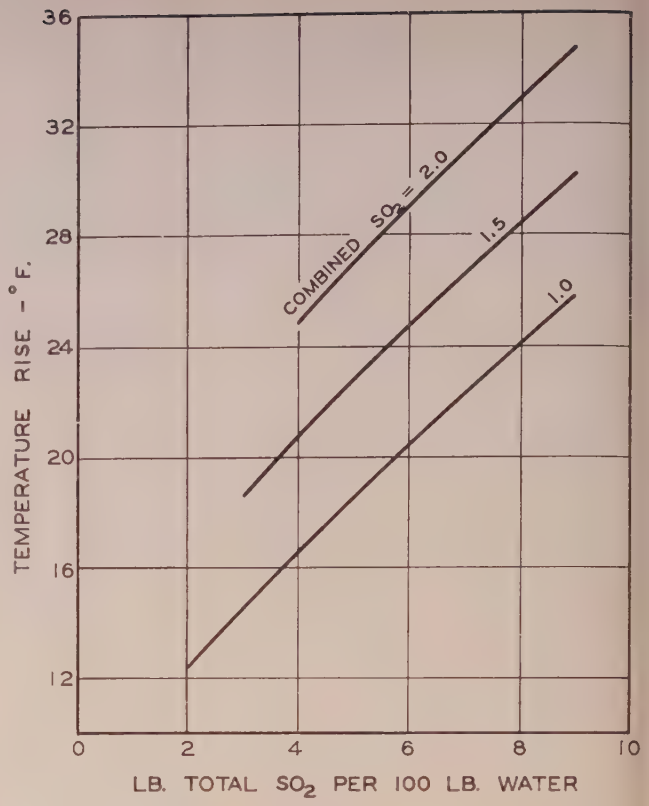

Fig. 1. Liquor temperature rise caused by heat of absorption

Table I. Heats of Formation, Solution, and Dilution at 18°C. and 1 Atmosphere (*4*)

Formula	*Mol. wt.*	*State*	*Heat of formation, B.t.u./lb. mole*
NH_3	17.03	Gas	19,800
SO_2	64.06	Gas	127,660
H_2O	18.02	Liquid	123,070
NH_4OH	35.05	Infinite dilution	157,900
NH_4HSO_3	67.11	Aqueous	324,630

NH_3, wt. %	*Heat of soln., B.t.u./lb. mole NH_3*	*Heat of infinite diln., B.t.u./lb. mole NH_3*	*SO_2, wt. %*	*Heat of soln., B.t.u./lb. mole SO_2*
50	11,700	3320	9	12,040
40	12,060	2960	8	12,110
30	14,350	670	7	12,240
20	14,500	520	6	12,360
10	14,820	200	5	12,510
5	14,930	90	4	12,650
2	15,020	0	3	12,940
Infinite diln.	15,020	..	2	13,300
			1	13,860
			0.5	14,530
			0.2	15,300

* Mill definitions are followed for the terms "combined," "free," and "total" sulphur dioxide. The "combined SO_2" refers to that required to form the sulphite of the cation present, and is equal to half the amount actually combined with the base as the bisulphite. The "free SO_2" is the difference between the "total" and the "combined."

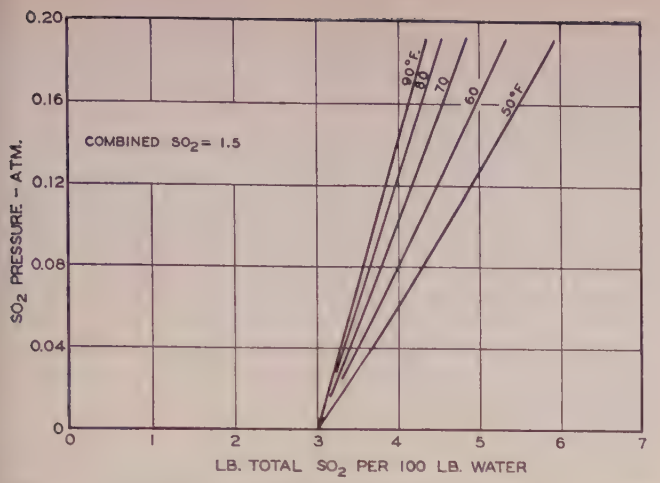

Fig. 2. Solubility of sulphur dioxide in ammonia-base raw acid

are calculated (*4*). In Fig. 1, the calculated temperature rise of the liquor, caused by the heat of absorption, is shown as a function of the total and combined sulphur dioxide contents.

The Solubility Relation

The solubility of a gas in a liquid affords an upper limit in terms of which the effectiveness of an absorption system may be judged. Solubility data for the ammonia-base cooking-acid system have been determined by Marriner and Whitney (*5*). Figure 2 shows several solubility isotherms for a raw acid of 1.50 lb. of combined sulphur dioxide per 100 lb. of water, calculated by interpolation from their data. For other values of combined sulphur dioxide, reference is made to their original paper.

From an absorption standpoint, the rather unusual nature of this solubility relation is worthy of note. As the ammonia liquor passes down the tower, ammonium hydroxide is first converted to ammonium sulphite, and then to ammonium bisulphite. No significant back pressure of sulphur dioxide is exerted by either of these compounds in solution. Further sulphur dioxide absorption results in the accumulation of sulphurous acid ("true free" sulphur dioxide), and this gives rise to an equilibrium pressure of sulphur dioxide over the solution. It is this equilibrium pressure which is markedly influenced by temperature. If a plant practices sulphur dioxide recovery to the extent that no "true free" sulphur dioxide is desired in the raw acid, then temperature increases in the absorber are not harmful.

Table II. Specifications for Commercial Packings

Nominal size, in.	*Outside diameter, in.*	*Length, in.*	*Wall thickness, in.*	*Number of pieces per cu. ft.*	*Weight of packing, lb./cu. ft.*	*Free gas space, %*	*Surface area of packing, sq. ft./cu. ft.*
Raschig Rings (Chemical Stoneware and White Porcelain, Dumped)							
1	1	1	1/8	1350	40	73	58
2	2	2	1/4	162	37	74	28
3	3	3	3/8	48	40	74	19
Single-Spiral Tiles (Stacked, Staggered)							
3	3 1/4	3	5/16	63	60	58	40
4	4	4	3/8	31	61	60	32
6	6	6	1/2	9	59	66	21
Triple-Spiral Tiles (Stacked, Staggered)							
3	3 1/4	3	5/16	63	69	50	50
4	4	4	3/8	31	65	53	40
6	6	6	1/2	9	68	60	24
Cross-Partition Rings (Stacked, Staggered)							
3	3	3	3/8	74	73	47	41
4	4	4	7/16	31	81	45	30
6	6	6	5/8	9	70	53	20

Data from U. S. Stoneware Co.

Packing Material

Among the more common packing materials are Raschig rings in the smaller size range, spiral tiles, partition rings, and the larger and less efficient wooden grids or checkerwork. The packing must possess adequate mechanical strength and corrosion resistance and, assuming these requirements, should be chosen on the basis of its absorption efficiency, its allowable gas and liquor rates, its pressure drop characteristics at operating flow rates, and its cost per unit volume.

In this connection it is to be noted that the least expensive packing material is often not the optimum. Many inexpensive materials provide low surface area for absorption and, hence, have a low absorption efficiency. Thus their use requires a larger absorption tower and often the added cost of the larger tower and the greater quantity of packing material more than offsets the lower unit cost. An obvious exception to this statement is in the conversion of an existing tower to a new use. Here, the available tower volume is fixed and the packing material is chosen accordingly. For example, if limestone-packed towers are to be converted to ammonia-base service by substitution of an inert packing material, the use of an expensive high-efficiency packing cannot be justified. Since the available tower volume is many times that required, an inexpensive low-efficiency packing is the obvious choice.

The manufacturers' specifications for several commercial packings are shown in Table II (*6*). Of the various packings, 2-in. Raschig rings, 3-in. single-spiral tiles, and 4-in. partition rings are believed to be close to the optimum for producing ammonia-base acid. The pressure drops and limiting flow rates for these packings are discussed below.

Liquor and Gas Rates

For any packing material, an increased gas rate results in a higher pressure drop through the tower and a consequently higher power cost for maintaining the gas flow. As the gas rate is continually increased, a point is reached where the pressure drop starts to increase at a faster rate (the loading point) and, finally, the tower floods. At the loading point, it is believed that the liquid hold-up in the tower starts to increase, thus decreasing the cross-sectional area available for gas flow. The pressure drop and the loading and flooding points vary with both the gas and liquor rate, but are much more dependent upon the gas rate.

The minimum liquor rate per unit of cross section is governed by the extent of the wetted packing area and the uniformity of the liquor distribution to be achieved. For a given packing, the wetted area is a function of the liquor rate but little quantitative information is available. For the case at hand, liquor

rates should not be less than 2000 to 3000 lb. per hr. per sq. ft.

As a design basis, gas rates of about 50 to 60% of the loading velocity are recommended. This will insure safe operation and will permit a considerable future expansion. For the recommended packings, these proposed flow rates are probably somewhat below the economic optimum rates from the standpoint of the power cost-tower diameter balance. The most extensive data on pressure drops and limiting flow rates in packings are those of Tillson (*7*); these and other data are well summarized in the Chemical Engineers' Handbook (*8*).

One of the principal factors governing the over-all economics of absorber installation and operation is the ratio of liquor to gas rate, and the relationship of this ratio to the slope of the equilibrium solubility line. As noted above, for sulphite acid production this ratio is fixed within narrow limits by the stoichiometry of the system, and is not subject to change by the designer. Because of the characteristics of the solubility relation, it would not be possible to realize optimum conditions in the whole tower, even if this ratio could be controlled. As might be expected, the combined operations of acid making and sulphite pulping have gradually evolved through experience to a set of conditions not far removed from the over-all optimum.

Tower Area

Having arrived at a choice of packing material and unit gas and liquor rates, the tower cross-sectional area is simply determined by the desired acid production.

The Packed Height

Just as the tower diameter is determined by the quantity of raw acid to be produced, the packed height is governed by the desired sulphur dioxide concentration in the raw acid, and by the desired completeness of absorption. For calculating the packed height, three relations are necessary, expressing, respectively, the material balance, the equilibrium solubility, and the rate of absorption. The first two have been discussed above, but must be translated into mathematical terms; the third is developed from the film theory.

For the quantitative expression of these relations, consider a packed section for producing raw acid. Water is supplied to the top of the section at a rate L lb. per hr. per sq. ft.; the water contains dissolved ammonia at a concentration governed by the desired combined sulphur dioxide content of the raw acid. Cooled sulphur burner gas is introduced at the bottom of the section at such a rate that G lb. of inert gas per hr. per sq. ft. pass upward through the packing. If C_1 and C_2 are the liquid concentrations at the bottom and top of the section in pounds of total sulphur dioxide per 100 lb. of water, and p_1 and p_2 are the corresponding partial pressures of sulphur dioxide in the gas entering and leaving, in atmospheres, then by a sulphur dioxide balance:

$$\frac{L}{100}(C_1 - C_2) = \frac{64G}{M}\left(\frac{p_1}{P - p_1} - \frac{p_2}{P - p_2}\right) \qquad (1)$$

In this expression, M is the molecular weight of the inert gas, and P is the sum of the inert gas and sulphur dioxide pressures. Normally, C_2 is equal to zero, and p_2 is very small (perhaps 0.001 atm.). This equation can also be applied over any portion of the packed section, to relate the liquid concentration and the gas strength. When p (gas strength) at any point is plotted against the corresponding C (the liquid concentration), the resulting relation is called the "operating line." For very dilute entering gases, or for low percentage absorptions, the operating line is nearly straight.

The equilibrium relation is always to be considered in connection with the operating line. As has been noted, the equilibrium solubility represents the ultimate which can be attained and thus, for isothermal operation, the operating line can approach, but never reach, the equilibrium line. In this case, because of the nature of the equilibrium relation, the operating and equilibrium lines can approach each other only at the very top and the very bottom of the packed section.

The operating diagram is used, together with an appropriate rate equation, to calculate the required tower height. The rate equations are developed from the film theory, and may take the form

$$dN = 64\,K_G a dh\,(p - p_e) = K_L a \rho dh(C_e - C)/100 \qquad (2)$$

In this expression, dN is the differential rate of absorption in pounds of sulphur dioxide per hour per square foot of tower cross section, dh is the differential tower height in feet, and the factors $(p - p_e)$ and $(C_e - C)$ are the over-all driving forces across both the gas and the liquid films, expressed in atmospheres or in pounds per 100 lb. of water, respectively. At any point in the tower, represented by liquid concentration C and gas strength p, the driving force $(p - p_e)$ is the vertical distance between the operating and the equilibrium lines. Correspondingly, the driving force $(C_e - C)$ is the horizontal distance between the operating and equilibrium lines. The quantity ρ represents the liquor density, which can be taken equal to that of water.

It will be noted that the rate equations have been set up in terms of the over-all effect of both film resistances, and that the driving forces have been defined accordingly. Thus, the quantities $K_G a$ and $K_L a$ are over-all capacity coefficients expressed in gas-film and liquid-film units, respectively, and are the essential factors needed for the determination of h, the packed height. This "over-all" procedure is justified only when both the operating and equilibrium lines are straight, as is practically the case in this instance, provided the calculation is made in steps (as it must be because of the changing absorption mechanism). For this simplified case, variation of the driving force through the packed section can be handled by equating the rate expressions to differential material balances and integrating to the following forms:

$$L(C_1 - C_2)/100 = 64K_G a h\,(\Delta p)_{l.m.} = K_L a \rho h(\Delta C)_{l.m.}/100 \qquad (3)$$

In these expressions $(\Delta p)_{l.m.}$* is the logarithmic mean of $(p - p_e)$ at the bottom and top of the zone being considered, and $(\Delta C)_{l.m.}$* is the corresponding logarithmic mean $(C_e - C)$.

Because of the changing absorption mechanism,

$$(\Delta p)_{l.m.} = \frac{(p - p_e)_1 - (p - p_e)_2}{\ln \frac{(p - p_e)_1}{(p - p_e)_2}} \qquad (\Delta C)_{l.m.} = \frac{(C_e - C)_1 - (C_e - C)_2}{\ln \frac{(C_e - C)_1}{(C_e - C)_2}}$$

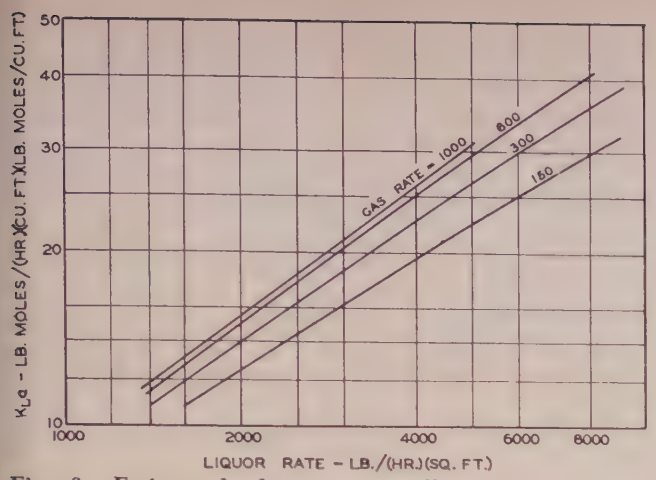

Fig. 3. Estimated absorption coefficients for sulphur dioxide in water at 80°F. (3-in. single-spiral tiles)

the main packed section of the tower should be designed in three parts. Each of the parts, or zones, will be discussed separately, starting at the base of the tower.

Build-up of "True Free" Sulphur Dioxide. The function of the bottom zone is to build up the "true free" sulphur dioxide content of the solution. All the ammonia has been converted to ammonium bisulphite previously, and the mechanism in this section (save for one difference to be noted) is one of the absorption of sulphur dioxide in water. The sulphur dioxide-water system has been studied extensively by Whitney and Vivian (*9*), using 1-in. ring packing. The work of these investigators demonstrates that both film resistances exert an important effect, with the liquid film resistance predominating. Thus, the appropriate design criterion is the capacity coefficient, K_La.

Using the capacity coefficients of Whitney and Vivian for 1-in. rings, with the less extensive data of Haslam, Ryan, and Weber (*10*) for 3-in. spiral tiles, it is possible to estimate closely the desired capacity coefficients for the packings of interest here. These estimated coefficients, for 3-in. single-spiral tiles at 80°F., are shown in Fig. 3.

The principal physical difference between the sulphur dioxide-water system and the build-up of "true free" sulphur dioxide in cooking acid lies in the inhibiting effect of the ammonium bisulphite on the hydrolysis of sulphurous acid. If the theories of Whitney and Vivian (*9*) regarding the relative rates of hydrolysis and diffusion are correct, the capacity coefficients for the cooking acid system may be somewhat higher than for water. This probability is borne out by the work of Han and Lewis (*11*) on another system in which the sulphurous acid hydrolysis was inhibited. Thus, the coefficients shown in Fig. 3 may be conservative.

It has been established from the data of Whitney and Vivian that the over-all coefficients increase significantly with increasing temperature. For temperatures markedly different from 80°F., adjustment of the coefficients should be made. However, the predominating effect of temperature on the capacity of this zone of a tower is, as pointed out before, its adverse influence on the equilibrium solubility.

Conversion of Ammonium Sulphite to Ammonium Bisulphite. Proceeding up the tower, the second zone is concerned with the conversion of ammonium sulphite to ammonium bisulphite. Here, the absorption of sulphur dioxide is followed by a chemical reaction, and the over-all coefficients of the first zone cannot be used. This case of absorption has not been studied sufficiently to establish the mechanism and to provide design data. Lacking this understanding, the best available procedure is to design on the basis of the gas-film coefficients presented below for the third zone. It should be pointed out, however, that the packed height calculated thereby may be somewhat smaller than it should be. This deficiency is not critical, because of the small packed height required in this zone.

Conversion of Ammonium Hydroxide to Ammonium Sulphite. The third zone serves to convert the ammonium hydroxide in the incoming liquor to ammonium sulphite. Here, as in the second zone, absorption is followed by chemical reaction. Recent work in this laboratory strongly indicates that this reaction is sufficiently rapid to eliminate the effect of the liquid film resistance, and that the absorption rate is controlled completely by the gas film. Thus, gas-film capacity coefficients can be used for design. The equilibrium sulphur dioxide pressure over the liquor can be taken to be zero in the calculation of the packed height.

Gas-film coefficients sufficiently reliable for design purposes are not plentiful. For sulphur dioxide, Whitney and Vivian (*9*) calculated gas-film coefficients from their data on 1-in. rings. From these data, the coefficients shown in Fig. 4 for 3-in. single-spiral tiles have been estimated. The effect of temperature on the capacity of this section is believed to be negligible.

Determination of the packed height for this zone completes the calculations for the main packed section. Having considered the three zones separately because of the different absorption mechanisms, it is no longer necessary to differentiate among them. The three packed heights may be added to yield an over-all height for this main section of the tower, and the three zones are merged into one and considered as a unit.

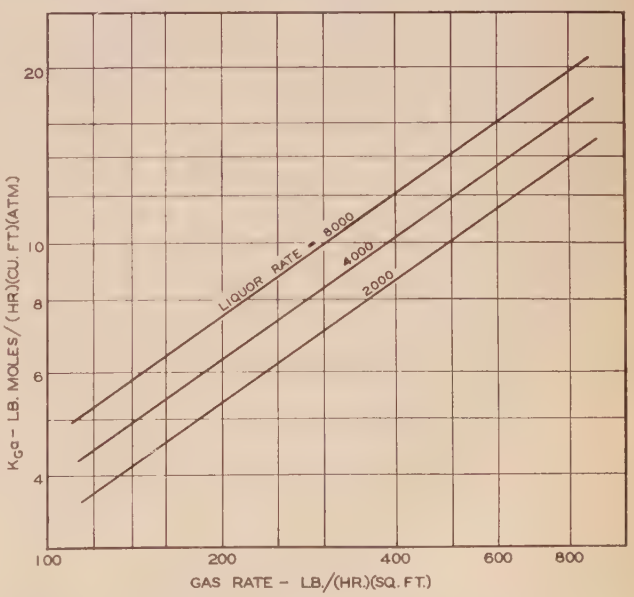

Fig. 4. Estimated absorption coefficients for sulphur dioxide in ammonia solutions (3-in. single-spiral tiles)

Recovery of Ammonia from the Exhaust Gas

A unique feature of an ammonia-base raw-acid tower is that provision must be made for the recovery of the ammonia which is stripped from the entering liquor by the exhaust gas leaving the main packed section. The large volume of inerts from the burner gas remove ammonia before it has become fixed as ammonium sulphite. One means for recovering this ammonia is to provide an auxiliary packed section at the top of the tower. This section is fed with a portion (or all) of the incoming water to the tower, and serves to remove ammonia from the gas. This water is then used to dilute the concentrated ammonia liquor to be fed to the main section, either within or outside the tower shell.

This auxiliary packed section can be designed in the manner discussed above, using appropriate data for the ammonia-water system. In this system, both film resistances may play an important part but, under most conditions, the resistance lies predominantly in the gas film. Thus, the design should be based on the gas-film concept.

The most reliable capacity coefficients for the ammonia-water system are those of Fellinger (*12*). His data for 3-in. triple-spiral tiles are shown in Fig. 5. Fellinger did not study single-spiral tiles but coefficients for this packing have been reported by Molstad, McKinney, and Abbey (*13*).

As an alternative to the ammonia-reclaiming section described above, a liquor recirculation system may be provided. In such a case, a part of the exit liquor is diverted, mixed with the ammonia feed and water, and fed back to the tower as the inlet liquor. This recirculation necessarily changes the operating line, lowers the driving force, and increases the height of the zones discussed above. On the other hand, it eliminates both the reclaiming and the hydroxide-sulphite conversion zones and produces higher transfer rates in the main section as a result of the increased liquor rate. The over-all packed height is generally about the same as in the previous case. One added advantage of the liquor recirculation system is that the tower may be shifted to calcium-base operation without undue danger of clogging difficulties.

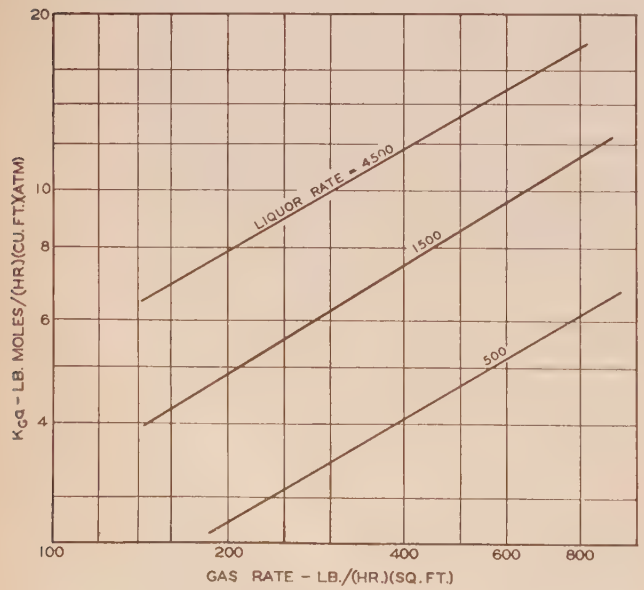

Fig. 5. Absorption coefficients for ammonia in water (Data of Fellinger for 3-in. triple-spiral tiles)

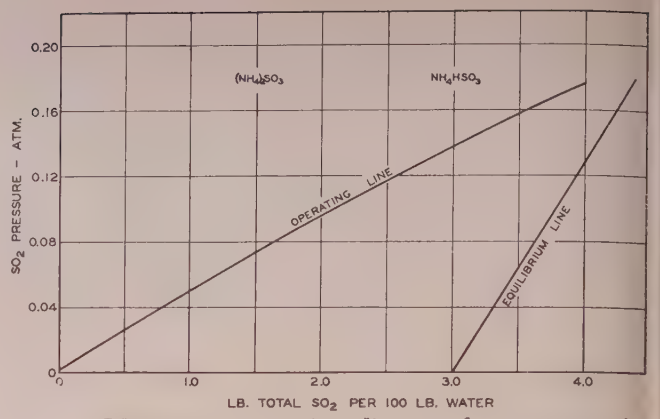

Fig. 6. Illustrative operating diagram for an ammonia-base raw-acid tower (83°F.)

ILLUSTRATIVE PROBLEM

To illustrate the use of the methods and the data which have been presented, the design of a new raw-acid tower for an ammonia-base sulphite pulp mill will be considered. The mill uses 225 lb. of sulphur per ton of pulp, and the desired raw-acid strength is 1.50 lb. of combined sulphur dioxide and 4.00 lb. of total sulphur dioxide per 100 lb. of water. The burner gas contains 18.0% sulphur dioxide (dry basis) and enters the tower saturated with water at 80°F. Ammonia is available as a 30% aqueous solution at 70°F., and well water at 60°F. will be used for acid making.

From the stated conditions, the quantity and composition of the raw acid and the incoming burner gas are fixed. The exhaust gas and inlet liquor quantities and compositions can then be determined by material balances. It is justified to neglect losses of ammonia and sulphur dioxide in the material balance calculations, and to assume that the exhaust gas leaves the tower saturated with water at 60°F. (the entering water temperature). The calculated quantities are shown in Table III, based on 225 lb. of sulphur (1 ton of pulp).

Table III. Material Balance over Raw-Acid Tower
Basis: 225 Lb. of Sulphur (1 Ton of Pulp)

	Pounds	*Moles*
Inlet burner gas		
Sulfur dioxide	450	7.03
Inert gas	897	32.00
Water	25	1.39
	1,372	40.42
Inlet liquor		
Ammonia	90	5.28
Water with ammonia	210	11.67
Dilution water	11,025	612.5
	11,325	629.45
Outlet liquor (raw acid)		
Total sulphur dioxide	450	7.03
Combined sulphur dioxide	169	2.64
Ammonia	90	5.28
Water	11,250	625.0
	11,959	639.95
Exhaust gas		
Inert gas	897	32.00
Water	10	0.56
	907	32.56

The thermal effects are best evaluated by a heat balance over the tower. A convenient datum level for this case is liquid water at 60°F. (the condition of the entering water). All sensible heat changes can be evaluated through the heat capacities (*14*), the enthalpy changes for water from the steam tables (*15*), and the heat of absorption from Table I. The heat capacity of 30% ammonia solution is very close to unity, and the heat capacity of the raw acid is taken to be equal to that of the water it contains. The summarized balance is shown in Table IV, again based on 225 lb. of sulphur.

Table IV. Heat Balance over Raw-Acid Tower

Basis: 225 Lb. of Sulphur (1 Ton of Pulp). Datum: Liquid Water at 60°F.

	B.t.u.
Inlet burner gas	
Sulphur dioxide	1,320
Inert gas	4,460
Water	26,700
	32,480
Inlet liquor	
30% ammonia solution	3,000
Dilution water	0
	3,000
Heat of absorption	
Dilution of 30% ammonia	3,540
Reaction NH_4OH (aq.) + SO_2(g) = NH_4HSO_3 (aq.)	206,500
Solution of "true free" sulphur dioxide	24,300
	234,340
Exhaust gas	
Inert gas	0
Water	10,600
	10,600
Outlet liquor (raw acid)	
By difference	259,220
Outlet liquor temperature = 83°F.	

Since the liquor temperature changes from 60 to 83°F. in passing through the tower, the solubility relation should reflect this change. However, since by far the greatest thermal effect is caused by the reaction of aqueous ammonia and gaseous sulphur dioxide, almost all the temperature change (about 19°F.) has occurred before the build-up of "true free" sulphur dioxide. Thus, for setting the equilibrium line, it is satisfactory to consider the operation isothermal at the outlet liquor temperature. The equilibrium line for 83°F. is shown in Fig. 6.

For purposes of illustration, 3-in. single-spiral tiles are chosen as the packing material.

At the base of the tower, which is the critical location from the standpoint of flooding, the total gas rate is 1372 lb. and the liquor rate is 11,250 lb. (water) per ton of pulp. Thus, the ratio of liquor to gas rate is 8.2. For this ratio, and for 3-in. single-spiral tiles, the loading velocity [from Tillson's data (*7*)] is about 1100 lb. per hr. per sq. ft. From the discussion above, safe operating gas and liquor rates are 610 and 5000 lb. per hr. per sq. ft., respectively, at the base of the tower. The corresponding inert gas rate is 400 lb. per hr. per sq. ft.

Having thus fixed the unit flow rates, the tower area can be calculated from the desired production rate. Table V shows the tower diameter as a function of the pulp production rate.

Table V. Raw-Acid Tower Diameter

Sulphur Consumption 225 Lb. per Ton of Pulp

Pulp production, tons per day	*Tower diameter, ft.*
50	2.4
100	3.5
150	4.2
200	4.9
300	6.0
400	6.9

The operating diagram for the main packed section is shown in Fig. 6. The operating line is calculated from equation (1), using the above-stated conditions. The partial pressure of sulphur dioxide in the exhaust gas from the section is arbitrarily taken as 0.001 atm. This is a loss of roughly 0.5% of the entering sulphur dioxide, most of which will be recovered in the auxiliary packed section for ammonia recovery. Using the operating diagram and the appropriate absorption coefficients, the height of each zone of the main packed section is determined by means of equation (*3*). Table VI summarizes the results of these calculations.

In order to design the auxiliary packed section for recovery of ammonia, it is necessary to estimate the amount of ammonia in the gas leaving the main packed section. An estimation can be made by assuming complete mixing of the ammonia with the incoming water, and considering the exhaust gas to have an ammonia content which is in equilibrium with this liquor. This probably sets up an ammonia loss from the main section which is too high, and the auxiliary section designed to handle this case will err on the safe side.

Assuming complete mixing, the ammonia content of the liquor fed to the main section is 0.80 lb. of ammonia per 100 lb. of water. For this concentration, the equilibrium pressure of ammonia at 60°F. is 3.8 mm. of mercury (*8*). Thus, the 400 lb. of inert gas leaving each square foot of tower cross section carries with it 1.23 lb. of ammonia. The ammonia content of the gas (dry basis) is 0.50 mole %.

Calculation of the required packed height for any desired ammonia recovery now involves setting up an operating diagram and proceeding as discussed above. For the recovery of 90% of the stripped ammonia, a packed height of 4.5 ft. is required (Table VI) The calculation was made assuming that half of the incoming water was introduced at the top of the am-

Table VI. Packed Height

Section	*Zone*	*Rate of absorption, lb./(hr.)/(sq. ft.)*	*Log mean driving force, lb./100 lb., (ΔC)l.m.*	*Log mean driving force, atm. (Δp)l.m.*	*Absorption coefficient* K_La	*Absorption coefficient* K_Ga	*Packed height (h) ft.,*
Main	Absorption of "true free" SO_2	50	0.66	...	27	..	4.5
	Conversion of $(NH_4)_2SO_3$ to NH_4HSO_3	75	..	0.10	..	11	1.1
	Conversion of NH_4OH to $(NH_4)_2SO_3$	75	..	0.017	..	11	6.3
Auxiliary recovery of NH_3		1.1	..	0.0020	..	7.2	4.5

[a] K_La = lb. mole/(hr.)(cu. ft.)(lb. mole/cu. ft.) = 1/hr. K_Ga = lb. mole/(hr.)(cu. ft.)(atm.)

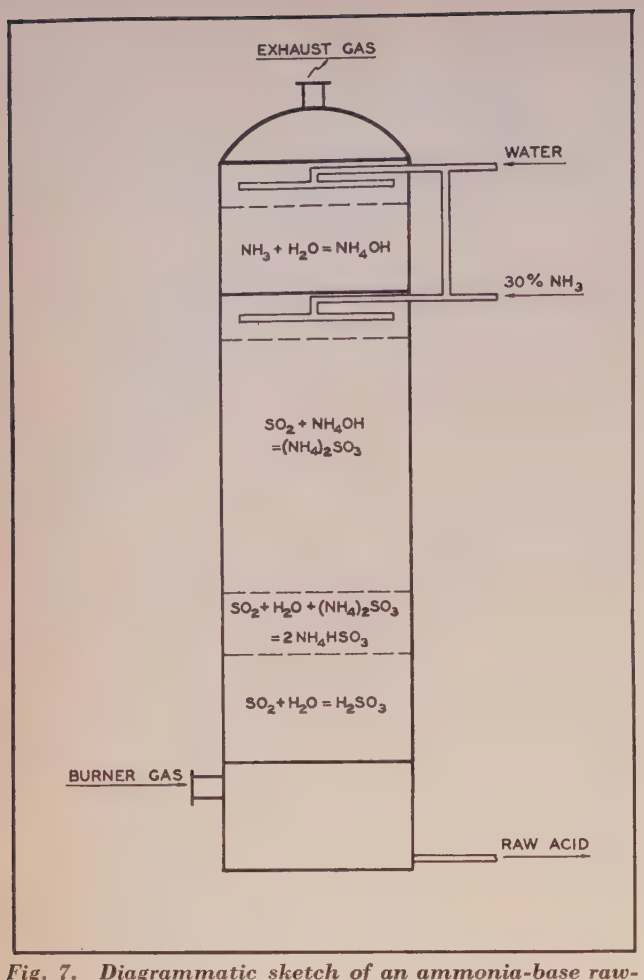

Fig. 7. Diagrammatic sketch of an ammonia-base raw-acid tower

monia-reclaiming section and that the other half was mixed with the 30% ammonia solution and fed between the sections. It should be noted that, in the absence of a better procedure, the ammonia coefficients of Fellinger (Fig. 5) were adjusted downward in the ratio of the dry surface areas of the single- and the triple-spiral tiles.

DISCUSSION

The hypothetical raw-acid tower which has been discussed is sketched diagrammatically in Fig. 7. Basically, it consists of two packed sections for the absorption of sulphur dioxide and for the reclaiming of ammonia (and sulphur dioxide), respectively. For the 3-in. single-spiral tiles, the packing should be stacked staggered on supporting base plates. Since the most common difficulty in packed tower operation is flooding at the base plate, precautions should be taken to choose base plates having a fractional open area as great as that of the packing itself. It is sometimes difficult to achieve this end and still maintain adequate mechanical strength.

Two liquor distribution systems are indicated. It is considered preferable to split the incoming water to the tower, introducing a portion (but not less than half) to the top distributor, and admixing the remainder with the ammonia solution before feeding to the distributor between the sections.

The required packed heights for the main and auxiliary sections have been calculated to be 11.9 ft. and 4.5 ft., respectively. These should be adjusted upward to allow for the relative ineffectiveness of the top few feet of a packed section because of imperfect liquor distribution. Actual packed heights of 15 and 6 ft. would probably be satisfactory for the stated flow rates. A further addition to the height of the main section might be made in order to provide for future increases in flow rates.

The data and calculations presented herein were based on the use of 3-in. single-spiral tiles because they represent a packing material of intermediate size and effectiveness. Although comparative data on packing performance are by no means plentiful, it is fairly well established that dumped 2-in. Raschig rings are 10 to 15% more efficient (lower packed height required), and that 4-in. cross-partition rings are appreciably less efficient. The relative effectiveness of 3-in. single and triple-spiral tiles is obscure. The efficiency of grid and checkerwork packings depends so greatly on the particular size and arrangement that no general statement can be made.

It is recognized that those factors which have been discussed by no means represent the complete tower design. Questions of over-all tower dimensions, materials of construction, structural design, and provision for easy control and maintenance are equally important. They will not be discussed here.

CONVERSION OF EXISTING TOWERS

Many existing raw-acid towers can be converted to ammonia-base operation, following the principles outlined above. In so doing, it is important to provide adequate absorption surface, to avoid high pressure drops and flooding conditions, and to guard against the loss of ammonia. As has already been noted, the available tower volume is often in excess of that required, and economical design suggests the use of low-efficiency and low-cost packings.

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ASSOCIATION NEWS AND EVENTS

TAPPI Annual Meeting

The Annual Meeting of the Technical Association of the Pulp and Paper Industry will be held at the Commodore Hotel, New York, N. Y., on Feb. 16–19, 1953.

Some of the papers tentatively scheduled for presentation are as follows:

Acid Pulping

Digester Heater Tube Survey
Sulphur Distribution in the Sulphite Pulping of Western Hemlock
Magnesium Bisulphite Recovery System
Conversion of Raw Acid System to Ammonia Base
Log and Chip Conveyer Belts
Black Liquor Solids Determination
"Acid Pulping with Sodium Sulphate Liquors," by George A. Richter, Eastman Kodak Co., Rochester, N. Y.

Water

"Centrifuge Analysis for Suspended Solids in White Water," by E. A. Mason and R. R. Quincy, Massachusetts Institute of Technology, Cambridge, Mass.

Chemical Engineering

"Experience with Digester Corrosion," by F. W. Flynn, Crown Zellerbach Corp., Camas, Wash.

Corrugated Containers

1. Résumé of the Corrugating Plant Waste Survey
2. The Glued Lap Box
3. Corrugated Liner Web Printing
4. Chromium Plating-Roll Performance

Structural Fibrous Materials

"Hardboard from Low-Grade White Oak," by Sidney L. Schwartz, Forest Products Laboratory, Madison, Wis.
"How Do TAPPI Standard Methods Fit the Needs of Hardboard Producers," by Wayne C. Lewis, Forest Products Laboratory
"Test Boards vs. Hand Sheets for Insulating Board Evolution," by C. K. Textor and Lee Eberhardt, Bauer Bros. Co., Springfield, Ohio
"Drainage Time Testing of Insulating Board Pulp," by Jules Perot, Flintkote Co., Whippany, N. J., and C. E. Hrubesky, Forest Products Laboratory, Madison, Wis.

Preparation of Papermaking Materials

"Surface Properties of Rosin Size Precipitate. I. Factors Affecting Formation of Resin-Aluminum Sulphate Complex," by E. F. Thode, J. F. Gorham, and R. H. Atwood, University of Maine, Orono, Me.
"Surface Properties of Rosin Size Precipitate. II. Effect of Foreign Ions on the Electrophoretic Mobility of Rosin-Aluminum Sulphate Complex," by J. F. Gorham and E. F. Thode, University of Maine.

Semichemical Pulping

"Experiments on the Kinetics of Sodium Sulphite Semichemical Pulping," by L. K. Doraiswamy and J. N. McGovern, Forest Products Laboratory, Madison, Wis.
"Semichemical Pulp from Mixed Eastern Hardwoods for Bond Paper," by J. N. McGovern and F. A. Simmonds, Forest Products Laboratory
"High Yield Pulping—An Estimate of the Future," by C. W. Converse, Sprout, Waldron & Co., Muncy, Pa.

Microbiological

"A Bacterium with a High Resistance to Organomercurials (*Achromobacter Guttatum*)," by John W. Appling and Stanley J. Buckman, Buckman Laboratories, Memphis, Tenn.

Pulp Purification

"Explosions in Chlorine Absorption Systems," by E. A. Mason, W. C. Bauer, and R. R. Quincy, Massachusetts Institute of Technology, Cambridge, Mass.

Plastics

Papers to be announced

Paper Deinking

Symposium on Waste Paper Quality
Symposium on Deinking Problems

Fundamental Research

Symposium: Management of Research in the Pulp and Paper Industry"
Research—What is it?: Its Development in Industry, Its Manpower, Its Organization, Its Records, Its Mechanics, and Its Housing
"Reaction Products of Lignin Model Compounds and Sodium Hydrosulphite," by Thomas G. Zentner, Institute of Paper Chemistry, Appleton, Wis.
"Study of the Alkaline Nitrobenzene Oxidation of Chloride Lignin," by Jack E. Jayme, Institute of Paper Chemistry
"Lignin—Carbohydrate Bond," by Elvin E. Harris, Forest Products Laboratory, Madison, Wis.
"Dye Adsorption on Wood Pulp. III. Effect of Pulp Processing on Specific Dye Adsorption," by Edward F. Thode, A. J. Chase, S. S. Majmudar, and D. R. Mackinnar, University of Maine, Orono, Me.

Papermaking (Cylinder)

"Testing Methods for the Analysis and Evaluation of Grit in Paper Stock," by W. A. White, Shartle Bros. Machine Co., Middletown, Ohio
"New Developments and Application of Automatic and Remote Controls as Applied to Paper Manufacture," by W. A. White, Shartle Bros. Machine Co.

Alkaline Pulping

Papers to be announced

Optical Properties

"Measurement of Gloss of Waxed Papers," by P. J. Gianacakes and F. A. McLaren, Standard Oil Co. (Indiana) Whiting, Ind.
"Fundamental Dimensions of Appearance Quantities," by R. S. Hunter, Washington, D. C.

Papermaking (Fourdrinier)

"Automatic Transfer Equipment," by J. E. Goodwillie, Beloit Iron Works, Beloit, Wis.
"The Deculator"
Tissue Paper Manufacturing Problems
Methods of Maintaining Basic Weight Determination of Fourdrinier Efficiency

Special Session

"Papermaking Properties of Fibers," by James d'A. Clark, Longview, Wash.

Miscellaneous Papers

"The Organization of an Engineering Laboratory," by A. W. Pomper, John Waldron Corp., New Brunswick, N. J.
"A New Principle for Consistency Control for Pulp and Paper Stocks in all Ranges Using the Resotronic Regulator," by Norman S. Grant, Spruce Falls Power & Paper Co., Kapuskasing, Ont.
"The Thermodynamic Principles of The Nash Hytor Vacuum Pumps," by A. E. Adams, Nash Engineering Co., South Norwalk, Conn.

The final program will be published in the January issue of *Tappi*.

Local Section Meetings

Pacific Section

The next meeting of the Pacific Section will be held at the University of Washington, Seattle, Wash., on Jan. 13, 1953. The meeting will be devoted to a consideration of mill routine control methods.

Lake States

The Lake States Section will meet at the Conway Hotel, Appleton, Wis., on Jan. 13, 1953. "Stainless Steel in the Pulp and Paper Industry" will be discussed.

Delaware Valley

On Jan. 22, 1953, the Delaware Valley Section will meet at the Engineers Club in Philadelphia, Pa. Ward D. Harrison, Vice-President of the Riegel Paper Corp., Milford, N. J., will be the moderator of a panel to discuss the "Developments of Paper Properties."

New England and Maine-New Hampshire

The annual meetings of the Maine-New Hampshire and New England Sections will be held at the Poland Spring House, Poland Spring, Me., on June 19–20, 1953.

Ohio

The Ohio Section will meet at the Manchester Hotel, Middletown, Ohio, on Jan. 8, 1953. Kenneth A. Arnold of the St. Regis Paper Co., Deferiet, N. Y., and R. C. Sturken of Frank W. Egan & Co., Bound Brook, N. J., will discuss "Polyethylene Extrusion Processes and Uses."

William P. Conant, Jr., of the Monsanto Chemical Co., Carew Tower, Cincinnati, Ohio, has succeeded R. D. McCarron as Treasurer of the Ohio Section.

Empire State

The annual meeting of the Empire State Section will be held at Whiteface Inn, Lake Placid, N. Y., on June 8–10, 1953.

The Technical Section of the Canadian Pulp and Paper Association will meet at the Saranac Inn., Saranac, N. Y., on June 4–6, 1953.

The Northern District of the Empire State Section will meet at the Woodruff Hotel, Watertown, N. Y., on Jan. 8, 1953. Wilfred Galley of the E. B. Eddy Co., Hull, P. Q., Canada, will duscuss "What Holds Paper Together." The Annual Ladies Night and Valentine Dance will be held at the Woodruff on Feb. 12, 1953.

The Central District of the Empire State Section will be held at the University Club, Syracuse, N. Y., on Jan. 9, 1953. Ernest Reed of Syracuse University will discuss "Control of Microbiological Growths in Pulp and Paper."

Lake Erie

The Lake Erie Section will meet at the Hotel Carter, Cleveland, Ohio, on Jan. 16, 1953. The meeting will be devoted to a consideration of "Testing and Quality Control."

Austrian TAPPI

On May 13, 1952, the Austrian Association of Pulp and Paper Chemists and Technicians was established at the University of Vienna, Vienna, Austria. Since the end of the recent war this group was a part of the Association of Austrian Chemists as the pulp and paper group. This organization was originally established about forty years ago. E. von Linhart is Chairman of the governing body.

1953 TAPPI Medal

At its meeting held in Chicago, Ill., October 16, the Executive Committee of the Technical Association of the Pulp and Paper Indistry awarded the TAPPI Medal to Roger C. Griffin, Retired, of Needham, Mass. Mr. Griffin was formerly Treasurer of Arthur D. Little, Inc., Cambridge, Mass., and is Chairman of the TAPPI Standards Committee. He is author of the much used Technical Methods of Analysis, published by the McGraw-Hill Book Co.

Merited Gift

At the annual luncheon of the TAPPI Engineering Conference held in Chicago Ill., on October 15, J. W. Hemphill of the Johns-Manville Corp., was the recipient of a fine wrist watch presented to him by the chairmen and secretaries of the committees of the TAPPI Engineering Division in appreciation of the many courtesies that Mr. Hemphill extended to the Division in its effort to improve the annual Engineering Conferences.

C. J. Silbert, J. W. Hemphill, and R. G. Macdonald

Eighth Paper-Plastics Conference

The eighth Paper-Plastics Conference of the Technical Association was held at the College of Forestry, State University of New York, Syracuse, N. Y., on Nov. 6–7, 1952. The Program Committee consisted of E. C. Jahn, New State College of Forestry, Chairman, Herman Mark, Polytechnic Institute of Brooklyn, and R. T. Nazzaro, Westfield River Paper Co.

The Wednesday morning (November 5th) session featured "Fundamental Resin Problems." R. Lindenfelson of the American Cyanamid Co., Stamford, Conn., presided as chairman. The following papers were presented:

"Recent Studies on the Morphology of Cellulose Fibers and Their Significance for Fiber to Resin Bonding," by B. Raaby, Polytechnic Institute, Brooklyn, N. Y.
"Polyester Resins and Paper Lamination," by Russell Dean, Interchemical Corp., New York, N. Y.
"Recent Progress in Measuring and Interpreting Adhesion," by H. Mark, Polytechnic Institute, Brooklyn, N. Y.

The Wednesday afternoon session was devoted to "Special Resin Systems and Technical Problems." Russell Dean of the Interchemical Corp., New York, N. Y., presided as chairman. The papers presented were as follows:

"Properties and Uses of Silicon Resins—A panel discussion led by A. J. Barry, Dow Chemical Co., Midland, Mich.
"A Melamine Type Resin for Beater Addition Process to Form Laminated Sheets or Molding Preforms," by R. Lindenfelser of the American Cyanamid Co.
"Abrasion Testing on Decorative Laminates with the Armstrong Abrader," by F. L. Graves, American Cyanamid Co., Stamford, Conn.

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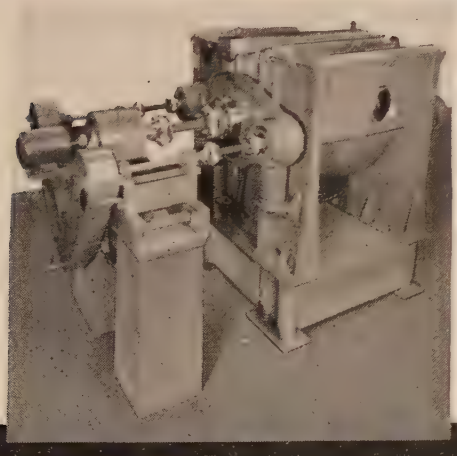

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"Melamine Resins in Paper Laminates—A panel discussion led by R. Lindenfelser, American Cyanamid Co.

The program of Thursday morning, November 6, considered "Plastics Applications to Paper." R. T. Nazzaro of the Westfield River Paper Co., Russell, Mass., presided as chairman. The following papers were presented:

"Machinery for Coating Paper with Plastics," by R. C. Sturken, Frank W. Egan & Co., Bound Brook, N. J.
"From Art to Science in Envelope Manufacturing," by P. B. Davidson, Mellon Institute for Industrial Research, Pittsburgh, Pa.
"Some Applications of Vinyl Acetate Polymers to Paper," by R. W. Reiter, National Starch Co., New York, N. Y.
"New Products Made by the Beater Addition Process," by Norman L. Greenman, Rogers Corp., Goodyear, Conn.
"Methods of Reverse Roll Coating," by R. F. Vokes, Dilts Machine Co., Fulton, N. Y.

The Thursday afternoon session was devoted to a panel discussion on "Problems in Application of Resins to Paper." Authors of previous mentioned papers constituted membership in the panel.

On both Wednesday and Thursday guided tours were arranged to inspect the new coating laboratory of the Dilts Machine Works at Fulton, N. Y.

In a later issue of *Tappi* E. C. Jahn, Chairman of the TAPPI Plastics Committee, will report in greater detail the papers presented and the discussions at the Conference.

Fibrous Agricultural Residues Conference

The Sixth Fibrous Agricultural Residues Conference of the Technical Association was held at the Northern Regional Research Laboratory, Peoria, Ill., on Oct. 27-28, 1952. S. I. Aronovsky, Chairman of the TAPPI Fibrous Agricultural Residues Committee, presided.

In addition to about 60 regular members of the Conference there were present 14 members of a team of the strawboard industry of the Netherlands.

Brief introductory talks were given by R. T. Milner, Director of the Laboratory, R. G. Macdonald, Secretary-Treasurer of the Technical Association of the Pulp and Paper Industry, and W. M. Scott, Assistant Chief of the U.S.D.A. Bureau of Chemistry and Industry, Washington, D. C.

The Monday morning (October 27) session was devoted to a consideration of "Straw and Hay Standards." W. H. Hosterman, Assistant Chief of the Standards and Research Testing Division, Production and Marketing Administration, U.S.D.A., Washington, D. C., outlined his experience of over 30 years in Government work on straw and hay grading.

This talk was followed by an enthusiastic round-table discussion on "Straw Specifications and Grading." This discussion was based on the following questions proposed by individuals in the strawboard industry prior to the meeting. A complete report of this discussion will be presented in a later issue of *Tappi* by Dr. Aronovsky when he has obtained clearance regarding the remarks made by the individuals who participated. The questions follow.

Round-Table Discussion

The following questions relating to "Straw Specifications and Grading" were discussed at the Round-Table at the Fibrous Agricultural Residues Conference.

Procurement:

1. Is it possible to control railroad cars to limit deliveries so as not to exceed unloading capacity at the mill?
2. It has been reported that some mills unload as much as 7000 tons in one week. What kind of equipment is used, how much labor is involved, and is unloading carried on for 24 hr. a day?

Baling:

1. What is the optimum size of straw bale desired?
2. What is the minimum density of bale required for stock piling the straw in ricks?
3. Is it possible to bale chopped straw 3 to 6 in. long?
4. Can a chopper be attached to the pickup baler so as to do the chopping and baling in one operation?
5. The available galvanized iron wire is too hard. Can anything be done to develop a satisfactory rust- or weather-resistant wire to replace black iron wire for baling wheat straw? Are lead-annealed or aluminum wire feasible?
6. What is the optimum size wire for use with automatic pickup balers?
7. What is the dockage for string ties? Does anyone refuse string-tied bales?
8. Is anyone actually specifying bale dimension and weight in buying straw for paper purposes?

Moisture:

1. In general what moisture-indicating instrument has gained widest acceptance by straw shippers?
2. What are the approved methods of checking the moisture content of straw as received?
3. What is the effect of the density of the bale on the determination of its moisture content by means of a Delmhorst moisture tester?

Chaff:

1. How can one readily determine the amount of chaff and other fine materials in the baled straw?
2. How can the amount of dirt and material other than cellulosic be determined readily?
3. What is the maximum allowable chaff content of baled straw and how is dockage for chaff determined?

Weeds:

1. Can anyone suggest a method of determining the weed content of baled wheat straw?
2. What is the maximum allowable weed content of straw for papermaking?
3. What is equitable dockage for weeds and how is it arrived at?
4. Can weeds be eliminated from straw after a wet growing season?

Appearance:

1. Is the suitability of straw for papermaking affected by the color, i.e., bright yellow vs. gray?
2. Does straw which has suffered some weathering affect the quality of the resulting pulp if the straw does not appear to have been attacked by microorganisms?

Storage and Preservation:

1. What is the total cost to the shipper for stock piling straw in the farm area?
2. What is the value per ton of stock-piled straw used as a basis for insurance?
3. What is being done about covering wheat straw ricks either in mill storage or on the farm?
4. What methods are used to preserve exposed straw ricks?
5. With regard to the use of borax, how much of this material is required per rick of 50 by 65 ft. top surface? What is the proportion of the amount of borax spread on the top three tiers of the rick?
6. How can spontaneous combustion fires in ricks of baled straw be eliminated?
7. What causes the loss of weight of baled field-dry wheat straw during a year's storage in a barn?

Types of Straws:

1. Does anyone use oats, barley, or rice straw for corrugating?
2. What are the effects of rice, oats, and barley straw on the properties of corrugating paper produced from these straws?
3. How do these straws stand up in stacking and storage?

On Tuesday evening a group dinner was held at the Pere Marquette Hotel in Peoria. C. O. Smith, Industrial Engineer for the Hiram Walker Co., Peoria, Ill., gave a talk on "What We Expect of Corrugated Shipping Containers." In this talk Mr. Smith traced the journey of a container through the bottle manufacturing plant, the distillery, and in shipment to remote locations. He pointed out the need for containers that can be stacked 20 high under humid conditions. Future containers will need to have surfaces that will take extensive printing to enhance their advertising value.

The Tuesday session was devoted to the projects being undertaken by the subcommittees of the Fibrous Agricultural Residues Committee.

In the afternoon special pulping operations were inspected in the pulp and paper laboratory of the Northern Regional Research Laboratory.

Wood Conservation is an Important Aim of the Paper Industry

ONLY two saw cuts saved per stick means approximately a half inch of wood. This seems like a small figure but becomes an astounding one when calculated for the vast amount of wood consumed in the mills today. Norton is building the pulpstones to make this saving possible — stones 66" wide and 69" wide for grinders with a power input up to 5000 horse power.

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Those present included:

Adair, G., Strawbuyer, Alton Box Board Co., Alton, Ill.
Albers, H., Member of the Board, General Labor Union, Amsterdam, Netherlands
Baker, H., Assistant to Vice-President, Swift and Co., Chicago, Ill.
Bracewell, S. G., Assistant Product Specialist, International Harvester Co., 180 N. Michigan, Chicago, Ill.
Brouwer, J., Efficiency Engineer, S.C.M.A.T. late Bedaux and Co., Ltd., Amsterdam, Netherlands.
Bush, V. E., Manager, Hinde and Dauch Paper Co., Fort Madison, Iowa
Buykx, P. A., Member of the Board Netherlands Catholic Union, The Hague, Netherlands
Buzzo, A. M., Sales, Pacific Coast Borax Co., 2295 Lumber St., Chicago, Ill.
Coray, W. G., Sales Engineer, Pacific Coast Borax Co., 5012 Euclid, Cleveland, Ohio
deHaan J., Papermaker, "deEendracht" Strawboard Mill, Appingedam, Netherlands
deMuinck Keizer, W. S., Owner-Managing Director, N. V. Strawboard Mill, Hollandia-Coevorden, Netherlands
Dill, R. R., Sales Representative, Bauer Brothers Co., Springfield, Ohio
Dow, J. W., Sales, Shartle Brothers Machine Co., Middletown, Ohio
Dunlop, G. A., General Manager, Ohio Straw Co., Coshocton, Ohio
Duvall, F. C., Assistant Engineer, Shartle Brothers Machine Co., Middletown, Ohio
Eberhardt, L. E., Sales Engineer, Bauer Brothers Co., Springfield, Ohio
Extrom, A., Technical Superintendent, Alton Box Board Co., Alton, Ill.
Fries, K. W., Technical Director, Rhinelander Paper Co., Rhinelander, Wis.
Grunwald, F. B., Superintendent, Consolidated Paper Co., Monroe, Mich.
Harrer, P. H., Assistant Chief Engineer, Allis-Chalmers Manufacturing Co., LaPorte, Ind.
Hawkes, V. L., Manager Straw Purchases, Container Corporation of America, Circleville, Ohio
Hellemans, R., Technical Manager, Beukema and Company Board Mill, Hoogezand, Netherlands
Henley, H. D., Strawbuyer, Container Corporation of America, Carthage, Ind.
Hermann, G. A., Vice-President and Sales Manager, The Hermann Manufacturing Co., Lancaster, Ohio
Hosterman, W. H., Assistant Chief, Standards Research and Testing Division, U. S. Department of Agriculture, Production and Marketing Administration, Washington, D. C.
Johnson, C. H. R., Vice-President and General Superintendent, Consolidated Paper Co., Monroe, Mich.
Johnson, D. E., Laboratory Technician, St. Regis Paper Co., Deferiet, N. Y.
Kasser, A., Consulting Engineer, Technopulp, Inc., 649 Upper Mountain Ave., Upper Montclair, N. J.
Koch, H. C., Technical Director, Weston Paper and Manufacturing Co., St. Marys, Ohio
Koski, J., Project Manager, Productivity and Technical Assistance Division, Mutual Security Agency, Washington, D. C.
Krancher, C. G., Plant Manager, Ball Brothers Co., Noblesville, Ind.
Landweer, D. G., Owner-Managing Director, Scholtens Board and Paper Mills, Groningen, Netherlands
Lewis, W. D., Superintendent, Muskingum Fiber Products Co., Coshocton, Ohio
Lowe, F., Strawbuyer, Terre Haute Division, Weston Paper and Manufacturing Co., Terre Haute, Ind.
Lyon, H., Strawbuyer, Terre Haute Division, Weston Paper and Manufacturing Co., Terre Haute, Ind.
Macdonald, R. G., Secretary-Treasurer, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York, N. Y.
MacLaurin, D. J., Research Associate, Institute of Paper Chemistry, Appleton, Wis.
Mulder, A., Foreman, "de Vryheid" Strawboard Mill, Veendam, Netherlands
Muller, F. M., Director, Netherlands Experiment Station for the Utilization of Straw, Groningen, Netherlands
Ohlson, J. L., Research Chemist, Swift and Co., Chicago, Ill.
Olthof, J., Managing Director, The Erica Strawboard and Paper Mills, Ouda-Pekela, Netherlands
Penning, J. A., Strawbuyer, Alton Box Board Co., Alton, Ill.
Porter, R. W., Editor, *Fibre Containers and Paperboard Mills*, 228 N. LaSalle St., Chicago, Ill.
Pyatt, E. M., Plant Chemist, Ball Brothers Co., Noblesville, Ind.
Sackett, H. C., Vice-President—Traffic and Purchases, Alton Box Board Co., Alton, Ill.
Scott, W. M., Assistant Chief of Bureau, Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, Washington D. C.
Shannon, W., Engineer, Allis-Chalmers Manufacturing Co., LaPorte, Ind.
Shiflet, R. D., Vice-President, Terre Haute Division, Weston Paper and Manufacturing Co., Terre Haute, Ind.
Shouvlin, R. J., Sales Engineer, Bauer Brothers Co., Springfield, Ohio
Springer, R. A., Staff Engineer, Diamond Alkali Co., Painesville, Ohio
Strapp, R. K., Assistant Chief, Chemical Pulping Group, Pulp and Paper Research Institute of Canada, 3420 University St., Montreal, Canada
Sutcliffe, H. M., Chemist, The Celotex Corp., Marrero, La.
Teyral, A. E., Technical Serviceman, Diamond Alkali Co., Painesville, Ohio
Thiel, L. V., Sales, F. C. Huyck and Sons, Rensselaer, N. Y.
t Hooft, H., Technical Manager, The Northern Wallboard Industry, Hoogezand, Netherlands
Trenité, J. N., Interpreter, Mutual Security Agency, Washington, D. C.
Van Der Veen, J., Assistant Technical Manager, Cooperative Cardboard Factory "Union," Oude-Pekela, Netherlands
Wells, S. D., Research Associate, Institute of Paper Chemistry, Appleton, Wis.
Witkowski, C. J., Sales Engineer, Black-Clawson Co., Middletown, Ohio
Zinkil, G. A., Special Representative, Central Fibre Products, 901 S. Front St., Quincy, Ill.

Northern Regional Research Laboratory

Aronovsky, S. I., In Charge, Pulp and Paper Section, Agricultural Residues Division
Ernst, A. J., Paper Technologist, Agricultural Residues Division
Lathrop, E. C., Head, Agricultural Residues Division
Mahon, H. I., Collaborator, Hawaiian Sugar Planters' Association, Honolulu, Hawaii
Majors, K. R., Technical Assistant to Director
Milner, R. T., Director
Naffziger, T. R., Chemical Engineer, Agricultural Residues Division
Nelson, G. H., Chemical Engineer, Agricultural Residues Division

Engineering Division

At the 7th Engineering Conference of the Pulp and Paper Industry held at the Morrison Hotel, Chicago, Ill., on Oct. 13–16, 1952, the following organization of the Division was established.

General Chairman—Charles J. Sibler, West Virginia Pulp & Paper Co., New York, N. Y.
General Secretary—Walter C. Bloomquist, General Electric Co., Schenectady, N. Y.

Chemical Engineering Committee:
Chairman—J. R. Lientz, Union Bag & Paper Co., Savannah, Ga.
Secretary—H. O. Teeple, The International Nickel Co., New York, N. Y.

Data Sheet Committee:
Chairman—Henry J. Perry, Lockwood Trade Journal Co., New York, N. Y.

Drying and Ventilating Committee:
Chairman—Curt A. Young, Riegel Paper Corp., Milford, N. J.

Electrical Engineering Committee:
Chairman—Ray W. Foster, Champion Paper & Fiber Co., Canton, N. C.
Secretary—G. W. Knapp, General Electric Co., Schenectady, N. Y.

Engineering Research and Machine Design Committee:
Chairman—John D. Lyall, Armstrong Cork Co., Lancaster, Pa.
Secretary—R. D. Irwin, Minneapolis-Honeywell Regulator Co., Brown Instrument Co. Div., Philadelphia, Pa.

Hydraulics Committee:
Chairman—K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y.

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Secretary—H. A. Stoess, Jr., Fuller Co., Catasauqua, Pa.

Mill Design and Economic Aspects Committee:
Chairman—R. A. Packard, Takoma Park, Md.
Secretary—P. A. Forni, Hyattsville, Md.

Mill Maintenance and Materials Committee:
Chairman—H. F. Parker, New York & Pennsylvania Co., Lock Haven, Pa.

Steam and Power Committee:
Chairman—W. M. Wyburn, Federal Paper Board Co., Inc., Bogota, N. J.
Secretary—J. Gottlieb, Westinghouse Electric Corp., New York, N. Y.

Alkaline Pulping Conference

The Sixth Alkaline Pulping Conference of the Technical Association was held at the Battle House, Mobile, Ala., on Nov. 14–16, 1952. Robert R. Fuller of the Gulf States Paper Co., Tuscaloosa, Ala., Chairman of the TAPPI Alkaline Pulping Committee was General Chairman of the Conference.

The Local Advisory Committee consisted of Erling Riis, Vice-President and General Manager of the Southern Kraft Division, International Paper Co., and D. E. Cousins, Vice-President of Hollingsworth & Whitney Co., both of Mobile.

Exceptionally fine arrangements were made for handling the conference by the Local Committee. A. W. Pesch, International Paper Co., and Robert B. Reynolds, Hollingsworth & Whitney Co., were co-chairmen, Ion Walker of the International Paper Co. was Secretary and J. H. Coil, Jr., of Hollingsworth & Whitney Co. was Treasurer. George Witham of the Orr Felt & Blanket Co. was in charge of Registration. Joe B. Homan of A. E. Staley Mfg. Co. was in charge of Arrangements and Hospitality. A. R. ("Red") Skelton of the American Cyanamid Co. was in charge of Transportation. Ion Walker was in charge of Publicity and Vernon D. Knight of the Eastwood-Nealley Corp. was in charge of the Ladies' Program.

The total attendance at the conference was about 375 individuals, including 60 ladies. An interesting program was arranged for the ladies, including, in addition to the men's social events, a visit to famous Bellingrath Gardens, a Get-Together Party at the Mobile Country Club, a boat trip down Mobile Bay and luncheon at the beautiful Grand Hotel at Point Clear, Ala.

All present at the meeting enjoyed a Hospitality and Smorgasbord Party on the evening of November 12. At the Conference luncheon on November 13, Erling Riis of the International Paper Co. presided as Toastmaster. The principal speaker was Judge Ben T. Turner who colorfully discussed current events.

On Friday the 14th, the entire day was devoted to plant visits to the mills of the International Paper Co. and the Hollingsworth & Whitney Co. Luncheons were served to the visitors to both mills through the courtesy of the respective companies.

The technical program was arranged by Fred W. Bishop of the Southland Paper Co., Lufkin, Tex. It consisted of four sessions held on November 12 and 13.

Sulphur and Soda Recovery

The Wednesday morning session consisted of a symposium on "Sulphur and Soda Recovery." Robert B. Reynolds of Hollingsworth & Whitney Co. presided as Moderator. The following papers were presented:

"The Use of Sulphur in Kraft Pulp Mills" by John E. Vassie, Technical Director of the International Paper Co., Southern Kraft Division, Camden, Ark.

As the pulp and paper industry has progressed, recovery furnaces and methods and practices have become more efficient. However, the recovery of sulphur has not kept pace with the increased efficiency in the recovery of soda. As the salt cake required to make up for soda losses has decreased, it has become necessary to add more and more sulphur to maintain the desired per cent sulphidity in the cooking liquor. Sulphur is, as a normal practice, shoveled into the recovery furnace through an open door, which not only is an inefficient use of the material, but also consumes considerable labor and affects furnace operation and steam production. The need for the design of a more efficient sulphur system has become more apparent since sulphur is a critical raw material in short supply.

While sulphur has been handled in the liquid state for many years in the sulphuric acid industry, the very small and variable flow required for continuous addition in the kraft industry has made the adoption of this system extremely difficult. However, the design of a liquid sulphur system giving satisfactory results for the pulp industry has been developed. This system consists of a cylindrical steam jacketed tank for melting the lump sulphur, a steam jacketed centrifugal pump, and steam jacketed pipe and fittings. Standard black iron is satisfactory for this service.

The sulphur is pumped to the recovery furnaces semicontinuously by the use of a timer switch on the pump motor. The timer is so designed that the pump is started every 5 min. and runs for any predetermined length of time, depending on the amount to be added. A steam jacketed sulphur rotometer has been tried but proved unsuccessful.

The molten sulphur is added at the rear of the recovery furnace through a nozzle which extends into the primary air duct. Due to the variable viscosity of sulphur care must be employed to control the liquid sulphur temperature between 290 and 310°F.

This sulphur system has resulted in a saving of substantial quantities of sulphur, considerable labor, and gives improved furnace operations.

Head table at the Alkaline Pulping Conference: A. W. Pesch, International Paper Co.; F. W. Bishop, Southland Paper Mills, Inc.; E. P. Wood, Hollingsworth & Whitney Co.; B. D. Turner, Guest Speaker; E. Riis, International Paper Co.; R. G. Macdonald, TAPPI; R. R. Fuller, Gulf States Paper Co.; and R. B. Reynolds, Hollingsworth & Whitney Co.

The Sixth Alkaline Pulping Conference Luncheon, Battle House, Mobile, Ala.

Puseyjones at Work . . .

Cutting winding wire grooves in Stream-Flow Cylinder Mould.

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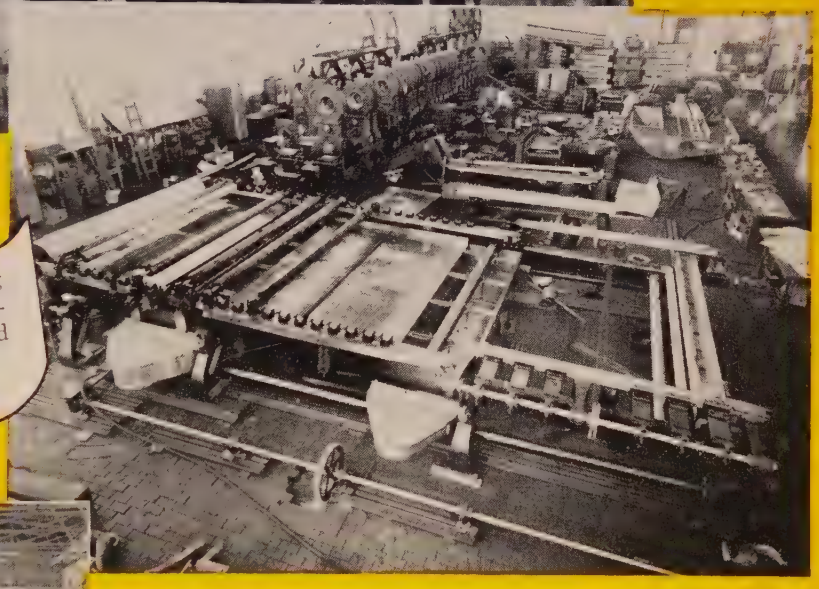

Erecting shop showing partially erected Fourdrinier Part for high-speed Puseyjones Machine.

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"Specific Heat of Sulphate Black Liquor" by R. L. Harvin and W. F. Brown, University of Florida, Gainesville, Fla.

(Note: This paper and all other papers presented will be published in full in a later issue of *Tappi*. Papers such as this one do not lend themselves conveniently to condensation).

"Submerged Combustion Evaporation" by William I. Weisman, Ozark-Mahoning, Tulsa, Okla.

Submerged combustion evaporation has been done commercially for over 15 yr., but only recently has its value become well

R. G. Macdonald, TAPPI; R. B. Reynolds, Hollingsworth & Whitney Co.; R. R. Fuller, Gulf States Paper Co.; and A. W. Pesch, International Paper Co.

known. Submerged combustion is defined as "burning a gaseous fuel in a special burner submerged completely beneath the surface of a liquid." It is accomplished in the Ozark-Mahoning burner by control of velocities of the air-gas mixture.

Principal components of a unit are: (1) blower and drive for combustion air, (2) burner assembly and accessories, (3) evaporating tank and stack, and (4) control panel and instruments.

High thermal efficiencies are obtained with submerged combustion because heat transfer is direct from products of combustion to solution. Hence, it is particularly applicable to solutions difficult to evaporate by conventional equipment because of either scaling properties, high viscosities, high boiling points, or corrosiveness.

Submerged combination burners require a gas for fuel or a high-grade fuel oil which can be vaporized before burning. In some areas these are expensive and may rule out the use of this method.

The multiple-effect system is not feasible with submerged combustion although much heat in the stack gases can be recovered by a condenser. Because of this limitation application of submerged combustion in the pulp and paper industry may be confined to specific situations. Thus where steam generating capacity of the plant is low it may be used economically because of the low capital cost.

Submerged combustion has been found suitable for concentrating waste solutions because of low capital investment and low maintenance. Pilot plant work has been done on neutral sulphite semichemical waste liquor. Evaporation of kraft mill black liquor by submerged combustion has been given consideration. A study by a consulting engineer led to the recommendation to consider submerged combustion for concentrating black liquor of 45 or 50% solids up to 65% solids after preconcentration in multiple effects.

The opinion was expressed that the high concentrations of solids needed for most economical operation of chemical recovery furnaces could be achieved more readily by submerged combustion than other methods. Other than preliminary testing, no extensive pilot plant work has been done on this problem. It is believed such work must be done by the industry before it can be determined that submerged combustion would prove of value as it has in other jobs.

"The Effect of Sulphidity on Bleached Sulphate Pulp Quality" by M. B. Pineo, Brunswick Pulp & Paper Co., Brunswick, Ga.

The program was concluded by a panel discussion on the "Use of Flue Gases for Black Liquor Evaporation." The members of the panel were: C. L. Durkee of the D. J. Murray Mfg. Co., Wausau, Wis.; W. J. Darmstadt, Babcock & Wilcox Co., New York, N. Y.; Frank W. Hockmuth, Combustion Engineering-Superheater, Inc., New York, N. Y.; and C. L. Tomlinson, Howard Smith Paper Mills, Ltd., Cornwall, Ont.

Recovery Room Operation

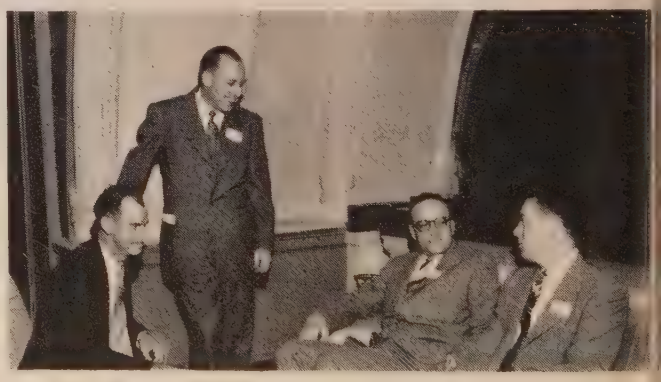
The Session of Wednesday afternoon dealt with "General Recovery Room Operation." John J. Goss of the Gaylord Container Corp., Bogalusa, La., presided as Moderator. The following papers were presented:

"New Developments in Recovery Unit Design" by Frank W. Hockmuth, Combustion Engineering-Superheater, Inc., New York, N. Y.

Since the vertical type of recovery unit was first introduced in 1938 there has been a definite trend toward the general acceptance of this design. At the present time this design has been accepted almost universally by the pulp and paper industries both here and abroad. Although there have been many improvements introduced in the past 10 yr. the basic arrangement of the furnace, boiler, and the superheater remains essentially unchanged.

A recent development has been an improvement in the design of the superheater for these units. In this design the superheater tubes in each element are arranged tangent to each other so as to form platens, these platen elements being placed on much wider spacing than had been used previously. This change has resulted in a superheater which is less susceptible to slag accumulations and which permits easier removal of slag formations by standard soot blowers. Operating experience with this type of superheater surface has indicated that the necessity for hand lancing in this section has been completely eliminated, even where the recovery unit is operated under severe overload conditions.

Another significant development has been the constant increase in recovery unit capacities. Prior to 1937 the largest recovery unit available had a capacity of 390,000 lb. dry solids per 24 hr. At the present time units having capacities of 1,120,000 lb. dry solids per 24 hr. are already in operation and even larger units are being projected. In addition to the increase in capacities, there has been a trend to higher steam pressures and temperatures. This constant increase in pressures and tempera-



J. E. Vassie, International Paper Co.; M. B. Pineo, Brunswick Pulp & Paper Co.; W. I. Weisman, Ozark-Mahoning Co.; and R. L. Harvin, University of Florida

tures has followed the requirements established by mill designers wherein their heat balances call for increasing the amount of power available from the steam required by the process.

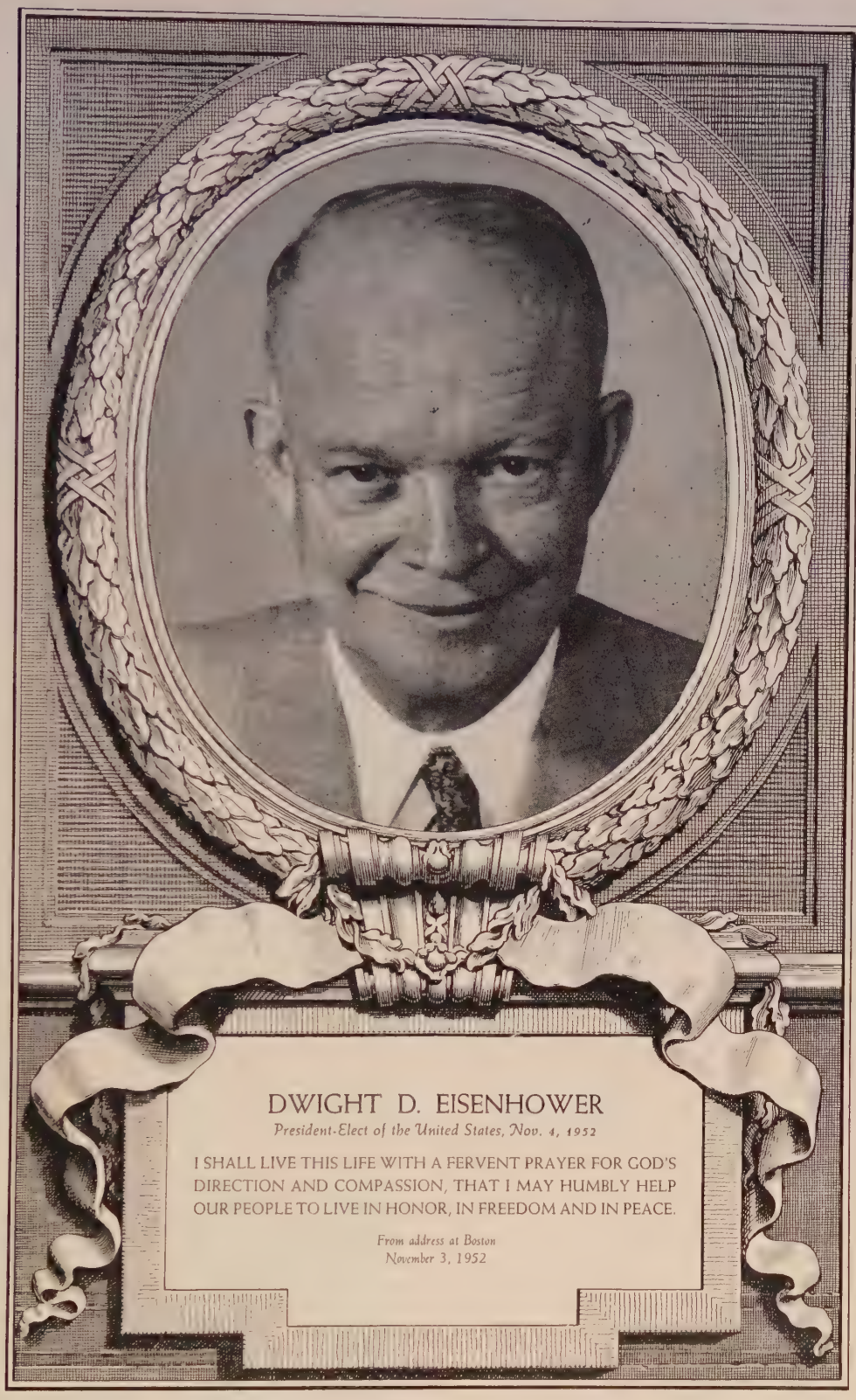
"New Developments in Recovery Furnace Design" by W. J. Darmstadt, Babcock & Wilcox Co., New York, N. Y.

"Instrumentation of Recovery Furnaces" by J. R. Upson and T. C. Johnson, Union Bag & Paper Corp., Savannah, Ga.

"Recovery Operation Corrosion Problems" by H. O. Teeple, International Nickel Co., New York, N. Y.

In designing the recovery unit and selecting the various component parts, it should be kept in mind that the objectives of such equipment as may be installed following the boiler are fivefold:

1. To recover or utilize as much as possible the heat content of the gases.


DWIGHT D. EISENHOWER
President-Elect of the United States, Nov. 4, 1952
I SHALL LIVE THIS LIFE WITH A FERVENT PRAYER FOR GOD'S DIRECTION AND COMPASSION, THAT I MAY HUMBLY HELP OUR PEOPLE TO LIVE IN HONOR, IN FREEDOM AND IN PEACE.
From address at Boston
November 3, 1952

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W. C. Meuly and B. K. Tremaine, E. I. du Pont de Nemours & Co., Inc.; E. R. Woodward, Mathieson Chemical Co.; B. F. May, Gulf States Paper Corp.; F. L. Cate, Rust Engineering Co.; and R. R. Fuller, Gulf States Paper Corp.

2. To reduce the gases to a temperature condition suitable for the fume recovery equipment.
3. To recover the chemical fumes carried in the stack.
4. To concentrate the heavy black liquor to a suitable consistency, as may be dictated by furnace requirement.
5. To design the integrated operation so that operating temperatures are safely above the dew point of the gas in an effort to minimize serious corrosion problems.

The session program was concluded by a panel discussion on "Recovery Furnace Operation." The members of the panel consisted of C. L. Tomlinson, Howard Smith Paper Mills, Cornwall, Ont.; Wilbur L. Orr, St. Regis Paper Co., Pensacola, Fla.; George H. Whiteside, Container Corp. of America, Fernandina, Fla.; and W. G. Reynolds, Gulf States Paper Corp., Tuscaloosa, Ala.

Kraft Mill Odors

The Thursday morning session consisted of a symposium on "Reduction of Kraft Mill Odors." Robert R. Fuller, Gulf States Paper Co., presided as Moderator. The following papers were presented:

"A Contribution to the Abatement of Sulphate Pulp Mill Odors" by Walter C. Menley and Breckinridge K. Tremaine of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

A method for air-borne kraft mill odor abatement was described which consists of masking the principal kraft mill malodors (volatile sulphur compounds) by means of odor masking agents introduced into the digesters and released simultaneously with the malodors throughout the kraft process. The modified kraft odors are less intense and less offensive. The simplicity of application, masking power at very high dilution, and pervasiveness were discussed. Laboratory studies and extensive field tests were described. An attempt at a rational explanation of odor masking was made based on semiquantitative odorimetric measurements of odor quantities and degree of masking. To this end the odor intensity of dilute aqueous solutions has been studied and the values of scent unit, scent value, and gram scent value have been introduced and defined. With their aid it is possible to express the odor content of a given odorous substance in numerical terms. From a study of the odor interaction of two odorous substances possessing known odor content, the values of mask unit, mask value, and masking ratio have been established by means of which the degree of masking action of one odor upon another can be expressed numerically.

The use of these odor measurements in devising appropriate odor masking agents for kraft mill odor abatement was discussed. The amount of air-borne kraft mill odors has been determined by interpretation of laboratory and literature data. The agreement between these results on one hand and the field observations on the other is reasonably close.

"Experiences in Masking Kraft Mill Odors" by Ben F. May, Gulf States Paper Co., Tuscaloosa, Ala.

The efforts at odor abatement by Gulf States Paper Corp. began in 1927 at the Braithwaite, La., mill. Production capacity was then 50 tons per day using two rotary digesters with make-up chemicals being salt cake and lime. Rotary furnaces were used for liquor incineration and smelt recovery.

A direct condenser was installed for the purpose of producing hot water from the flash steam during digester blows. Use of this hot water for pulp washing was soon dropped due to odor contamination of the pulp. However, it was brought to management attention that complaints regarding odor became negligible after the condenser went into operation. Chlorination of the condenser water to obtain odor-free hot water and to minimize odors in the plant area was unsuccessful.

Soon after operation began (1929) at the new mill in Tuscaloosa, Ala., a direct condenser was installed for the digester blow gases. Also installed was a turpentine condenser system composed of primary and secondary cyclones and two Scott evaporator effects as condensers. Except during breakdowns, malfunctions and poor operation, this equipment did a fair job of abating odors.

During the ensuing years old equipment has been improved and new equipment installed for handling gaseous effluents. Since 1949 the production rate has been 350 tons per day from 8 stationary digesters. Equipment now in use does not give total abatement, but there is a wide margin of improvement over odor conditions prevalent immediately following World War II.

The equipment presently in use for handling gaseous effluents is as follows:

1. Continuous gas-off relief system at digesters. Gases pass through cyclone separator thence to direct condenser (tray type).
2. Two indirect type condensers for digester blow gases. Hot water produced for pulp washing.
3. Direct condensers on first effect black liquor evaporators.
4. Cottrell precipitators on recovery furnace stacks.

Due to lack of total abatement with equipment, a search was begun for some other method. As a result, in September, 1951 this mill was the first to start on a completely new approach which in some quarters is called "Odor Masking." This involves the use of aromatic compounds which are introduced into the process at various points. So far, six different mixtures of these aromatics have been tried. As to their effectiveness, management is still mildly skeptical. The result of an odor poll taken during the trials indicated a slight improvement, but was not sufficient to be conclusive. However, trials will continue with the hope that a *sure-cure* mixture will be developed.

"Design of Chimneys for Odor Dispersion" by F. L. Cate, Rust Engineering Co., Birmingham, Ala.

The problems of air pollution, and certainly odors can be considered a type of contamination, cannot be solved merely by building a chimney. A chimney can be designed only to deliver gases, fumes, or smoke into the atmosphere at a certain elevation. Air turbulence, wind velocity, temperature, and humidity are the dispersing agents.

A theory has been developed that at a distance of ten times the chimney height smoke concentration at ground level reaches a maximum. Concentration at that maximum varies inversely as the square of the chimney height, and at distances greater than fifty chimney heights the concentration varies as the inverse square of the distance and is independent of the chimney height. This tends to show that, by doubling the chimney height, the maximum ground concentration could be materially reduced. There are cases on record, however, where as much as 10 yr. were required to determine that agricultural crops were adversely affected from concentrations that were settling to the ground as far away as 75 miles from the point of discharge. This would indicate that, regardless of height, some distant place will at some time be affected by the contamination being discharged.

There are various means of eliminating more positively the odors and contaminants than by depending on a chimney of a certain height. Collectors of various types, both mechanical and electrical, where properly applied will eliminate to a great extent many injurious contaminants. Catalytic agents intro-

W. J. Darmstadt, Babcock & Wilcox Co.; C. L. Durkee, D. J. Murray Mfg. Co.; F. W. Hochmuth, Combustion Engineering-Superheater, Inc.; C. L. Tomlinson, Howard Smith Paper Mills Ltd.; standing: R. B. Reynolds, Hollingsworth & Whitney Co.

Walworth

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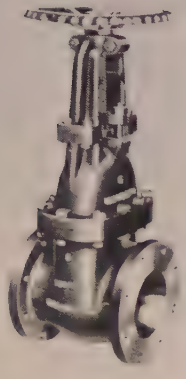

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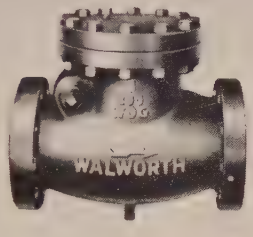

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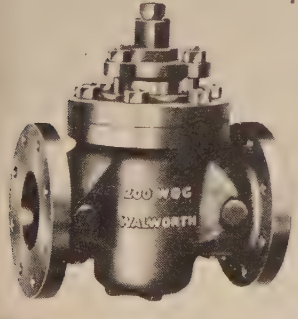
WALWORTH Pressure-Seal Cast Steel Gate Valves exemplify the greatest improvement in high-pressure, high-temperature valve design. The internal pressure keeps the body-to-bonnet joint tight. Series 600: 1½" and larger; Series 900: 3" and larger; Series 1500: 1" and larger.



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duced into the effluent stream, and which promote a chemical reaction, have been effective in eliminating obnoxious discharges.

A chimney alone is not the answer to odor elimination, but a chimney carefully designed for the service intended will aid in delivering the gases at a height so that when spread out over a certain area the ground concentration will be minimized.

"Chlorine Dioxide for Odor Control" by Eric R. Woodward, Mathieson Chemical Corp., Baltimore, Md.

Despite the extensive literature published over a period of several years on the subject of kraft mill odors, the nuisance is

Judge Ben D. Turner; Erling Riis, International Paper Co.; and E. P. Wood, Hollingsworth & Whitney Co.

still with us, and complaints from the neighbors continue to be a source of concern to pulp mill operators.

Since a similarly vexing problem has been encountered in other industries, and court orders to desist, or shut down plants, are becoming more frequent, it is worth while to consider how they are dealing with the situation. Certain similarities may be observed in the types of chemicals which cause the odors emanating from kraft mills and from these other plants. Based therefore on the practical results achieved in other industries, it appears worth while to experiment with chlorine dioxide on kraft mill odors.

The successful application of chlorine dioxide in this general field has so far been limited to:

1. Taste and odor improvement in public water supplies.
2. Reduction of atmospheric pollution in the vicinity of animal fat and fish rendering plants, soap manufacturing and fat splitting plants.

The former application has been in operation in the United States for the past 7 yr., and we now have about 150 chlorine dioxide installations operating in water works throughout this country and in Canada.

The latter application has come into commercial operation within the past year, and we have saved a few rendering plants from being shut down by court order. It is interesting to note that, in two cases, chlorine alone had failed to solve the problem.

A snap judgment on the subject often poses the objection that chlorine dioxide is too expensive as a remedy for industrial plant odors, the elimination of which represents an overhead cost to the plant owners. In this connection it is well to note that in the animal fat industry they are now experiencing a period of very low prices for their principal product—Inedible Tallow—the top grade of which is sold in the current market for about $5^1/_2$¢ per lb. A year ago the price was $9^1/_2$¢ per lb. In August, 1946, the same product was sold in the open market for 26¢ per lb. Yet in spite of this situation some renderers would rather spend the money on chlorine dioxide control of odors than have their plant shut down, or be forced to move it elsewhere.

It should also be remembered that this problem is more far-reaching than the operation of individual plants. The general question of Public Relations comes into it, and I was told recently by a prominent engineer in the Fish Rendering Industry that objections are being made to the building of new plants in certain areas because of the obnoxious odors they are expected to produce. This widens interest in adequate odor control to builders of new plants and suppliers of equipment for industries which normally produce obnoxious odors.

General Session

On Thursday afternoon Fred W. Bishop of Southland Paper Mills, Inc., Lufkin, Tex., presided as Moderator of the General Session. The following papers were presented:

"Deterioration Losses in Stored Southern Pine Pulpwood" by Ralph M. Lindgren, Pathologist, Forest Products Laboratory, Madison, Wis.

Studies since 1948 in Mississippi, Louisiana, and Arkansas showed the following losses in specific gravity of pine pulpwood during storage: *rough* bolts during summer storage (April 15 to October 15)—2 to 4, 6 to 8, and 8 to 10% after 2, 4, and 6 months respectively; winter storage for corresponding periods—0 + to 1, 1 to 3, and 3 to 5%. After one full year of storage losses ranged from 11 to 15%. *Peeled* pulpwood of average size deteriorated most rapidly during the first 4 months of storage regardless of season. Losses ranged from 2 to 7 after 4 months and 3 to 9% after 1 yr., but usually were from 4 to 6 and 5 to 8% respectively. Large bolts (10 in. +) continued to deteriorate steadily; losses after 1 yr. often were double (12 to 14%) those for average size pulpwood.

Pulping trials on some of the test wood by the U. S. Forest Products Laboratory, Madison, Wis., indicated that chemical composition had changed little during storage; therefore losses in yield of sulphate and groundwood pulps on a wood volume basis were proportional to decreases in specific gravity of the pulpwood during storage. The principal effect of storage on groundwood pulp was a decrease in brightness. Except for constant tensile strength, sulphate pulps from wood stored for long periods showed lower strength properties than those from green wood. The greatest reductions were in sulphate pulps from rough wood stored 1 yr.; they approximated 20% in bursting strength, 25% in tearing resistance, and 75% in folding endurance. Measurable effects on sulphate pulp quality were indicated if specific gravity losses in stored wood exceeded about 3% (reached by both rough and peeled pulpwood after about 2 months of summer and 5 months of winter storage).

Indicated practices for reducing storage losses, other than storing only as long as necessary and using oldest material first, were: rough pulpwood—favor winter and large and long bolts for storage, store in large unaerated piles or in water if possible, spray ends of freshly cut bolts with 4% sodium fluoride in water; peeled pulpwood—hasten drying by ventilating piles, favor small bolts for storage or split large ones, peel quickly after cutting, spray or dip immediately after peeling with 4% sodium fluoride, favor winter storage (generally, but not always helpful).

"Turbulent Suspension Burning of Wood Refuse and Other Fuels" by Otto de Lorenzi, Combustion Engineering-Superheater, Inc., New York, N. Y.

(*Note:* Mr. de Lorenzi's paper was followed by a film showing burners illustrating his subject).

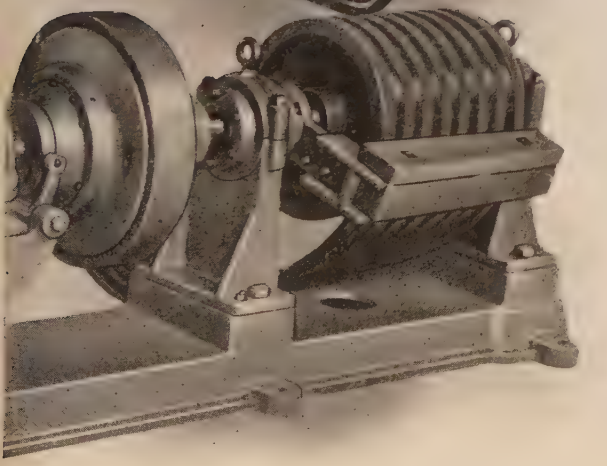
"Evaluation of Bleached Kraft Pulps for Paperboard Manufacture" by R. L. Lewis and J. J. Higgins, Ohio Boxboard Co., Rittman, Ohio

The evaluation of bleached kraft pulps has been undertaken by The Ohio Boxboard Co. as part of a program to determine what

F. W. Bishop, Southland Paper Mills, Inc.; Otto de Lorenzi, Combustion Engineering-Superheater, Inc.; J. J. Higgens, The Ohio Boxboard Co.; D. C. Gillespie, The Dorr Co.; and A. W. Pesch, International Paper Co.

sources of pulp could be used satisfactorily in the production of high quality folding boxboard. The program has consisted in comparative laboratory evaluations on kraft pulps from the principal pulp producing sections of the country, representing many different species of wood.

In the production of high quality folding boxboard, control of the physical properties of the top liner becomes one of the most important factors. The scoreability, uniformity of appearance and printability are almost entirely dependent on pulp used in the top liner furnish. As with most factors in paper productio



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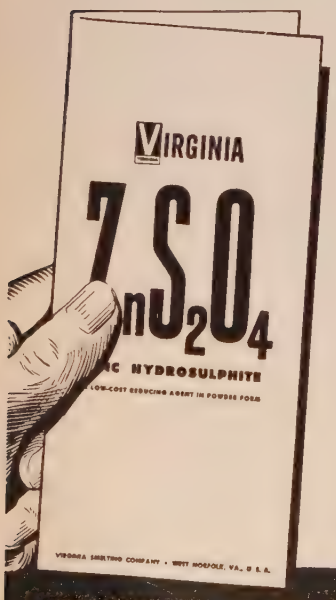

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compromises must be made in an attempt to reach the optimum performance; therefore, the evaluation has been based on a number of factors.

The factors considered important in the mill which may be studied by means of laboratory tests are shown in the following table:

Mill	*Laboratory*
Power requirements	Time required to reach operating freeness
Scoreability	Bursting strength and tearing strength
Printability	Pressure-smoothness relationships

Several tables and charts showing how the different pulps can be rated are presented with the general conclusion that kraft pulp from the Northeast shows the greatest potentialities for use in top liner furnishes.

"Some Notes on Current Recausticizing Practice" by D. C. Gillespie, The Dorr Co., Stamford, Conn.

Results of a recent survey of continuous recausticizing systems in 29 Southeastern pulp mills are reported. Reference is also made to certain variations from standard practice recently incorporated in mills elsewhere.

During the survey, maintenance and operating problems were freely discussed with superintendents and operators with the aim of improving methods and designs through closer collaboration. Over-all operations were reported to be good with recausticizing rooms producing substantially uniform cooking liquor of desired strength and clarity. Certain phases of the operation, however, were found to need additional attention and study, these being specifically the slaking operation, the maintenance of diaphragm pumps, and corrosion and plugging of lines in certain areas. Some suggested procedures for minimizing these difficulties are included in the article, but the nature of the process is such that continued improvement will provide a never-ending challenge.

Chemical analyses of cooking liquors were reported by 27 kraft mills. Average values are as follows (in lb. per cu. ft. as Na_2O): total titratable alkali, 7.58; NaOH, 4.58; Na_2CO_3, 1.19; and Na_2S, 1.85. Using TAPPI Standard terms, the average activity is 84.2%; sulphidity, 24.4%; causticity, 60.0%; and causticizing efficiency, 79.3%. Reports from 25 kraft mills were used in arriving at the following average figures: reburned lime production, 440 lb. per ton pulp; reburned lime availability, 86%; new lime make-up, 51 lb. per ton pulp; and kiln efficiency, 14 million B.t.u. per ton lime. Kraft mills surveyed were found to be operating an average of about 7 percentage points below the calculated equilibrium causticizing efficiency.

A new unit type green liquor clarifier and a dregs washer of similar design have been introduced and tested. Both are giving improved performance over the tray types. Due to its simplicity, the new design has the additional advantages of lower capital costs and ease of operation and maintenance.

Two variations of the standard recausticizing flowsheet are noted: (1) two-stage slaking, in which reburned lime is discharged directly from the kiln into a large primary slaker, the overflow from which gravitates to a combination slaker where make-up lime is added through a gravimetric feeder and unslaked material is removed by the classifier; and (2) two-stage causticizing, in which primary causticization is carried out in the presence of excess lime, this excess being causticized later in a secondary step with either strong or weak carbonate liquor. A flowsheet for each variation is presented for comparison with the standard system.

"Kraft Mill Effluents" by A. W. Pesch, Southern Kraft Division, International Paper Co., Mobile, Ala.

The membership of the TAPPI Alkaline Pulping Committee that sponsored this conference is as follows:

R. R. Fuller, Gulf States Paper Co., Tuscaloosa, Ala.
P. B. Borlew, Container Corp. of America, Fernandina, Fla.
H. Y. Charbonnier, Union Bag & Paper Corp., Savannah, Ga.
K. G. Chesley, Crossett Lumber Co., Crossett, Ark.
G. L. Clark, Coosa River Paper Co., Coosa Pines, Ala.
J. J. Goss, Gaylord Container Corp., Bogaloosa, La.
K. M. Guest, National Container Corp., Jacksonville, Fla.
E. A. Harper, Hudson Pulp & Paper Co., Palatka, Fla.
W. P. Lawrence, Champion Paper & Fibre Co., Hamilton, Ohio
J. McK. Limerick, Bathurst Power & Paper Co., Bathurst, N. B.
M. B. Pineo, Brunswick Pulp & Paper Co., Brunswick, Ga.
R. H. Stevens, National Container Corp., Jacksonville, Fla.
Henry Vranian, Chesapeake Corp. of Virginia, West Point, Va.
A. P. Yundt, Camp Manufacturing Co., Franklin, Va.

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The APPA will be meeting at the Waldorf-Astoria on the dates of Feb. 16, 17, 18, 19. TAPPI will hold its annual convention concurrently at the Hotel Commodore.

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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Charles E. Adams, Shift Chemist, St. Regis Paper Co., Pensacola, Fla., a 1948 graduate of Alabama Polytechnic Institute.

Harold E. Adams, Vice-President and Chief Engineer, The Nash Engineering Co., South Norwalk, Conn., a 1916 graduate of Middlebury College.

Daniel E. Bergsma, Jr., Laboratory Technician, The Orr Felt & Blanket Co., Piqua, Ohio, a 1952 graduate of Western Michigan College.

Vernon B. Bodenheimer, Southern Representative, Stebbins Engineering & Manufacturing Co., Watertown, N. Y., a 1948 graduate of North Carolina State College.

Bruce E. Brooks, Assistant General Superintendent, The Brown Paper Mill Co., Inc., Monroe, La. Attended Ouachita Junior College.

George F. Bryant, Export Sales, Union Bag & Paper Corp., New York, N. Y. Attended Academy of Aeronautics, and International Correspondence School courses.

Robert F. Caswell, Jr., Student, New York State College of Forestry, Syracuse, N. Y.

William H. Chambers, Sales Engineer, Reliance Electric & Engineering Co., Syracuse, N. Y., a 1947 graduate of Case Institute of Technology.

Peter A. Charest, Chief Engineer, St. Raymond Paper Ltd., Montreal, P. Q., Canada, a 1949 graduate of the University of Toronto.

Chien Chu, Head, Dept. of Pulp & Paper, Taiwan Forest Research Institute, Taipeh, Taiwan, China, a 1946 graduate of the University of Minnesota with a Ph.D. degree.

Oscar P. Cohen, Group Leader, Monsanto Chemical Co., Everett, Mass., a 1941 graduate of Harvard University with a Ph.D. degree from Clark University.

William J. Copeland, Chemical Engineer, International Paper Co., Research Div., Glens Falls, N. Y., a 1948 graduate of Cornell University.

John E. Cornell, Trainee, Hammond Bag & Paper Co., Wellsburg, W. Va., a 1950 graduate of the University of Florida.

Gerald E. Daly, Sales Engineer, Shartle Bros. Machine Co., Middletown, Ohio.

Victor D. Davis, Jr., Chemist, The Brown Paper Mill Co., Inc., Monroe, La., a 1952 graduate of Louisiana Polytechnic Institute.

Charles E. Elliott, Student, Western Michigan College, Kalamazoo, Mich.

Wilhelm G. Gaertner, Chemist, Deutsche Gold-und-Silber-Scheideanstalt vormals Roessler, Frankfurt/Main, Germany, a 1952 graduate of the Technical University.

Hans W. Giertz, Research Chemist, Swedish Forest Products Research Laboratory, Stockholm, Sweden, a 1940 graduate of The Royal Institute of Technology.

Charles F. Gosnell, State Librarian and Assistant Commissioner of Education, New York State Library, Albany, N. Y., a 1930 graduate of the University of Rochester, and a 1937 graduate of Columbia University School of Library Service.

John L. Grady, Electrical Supervisor, Oxford Paper Co., Rumford, Me., a 1915 graduate of the University of New Hampshire.

Ronald L. Hamilton, Student, Western Michigan College, Kalamazoo, Mich.

Edgar W. Heelas, Owner, Cellucrepe Co., High Point, N. C., a 1926 graduate of the University of Pennsylvania.

Gerrit W. Heinsius, Managing Director of Paper Mill, Van Gelder Zonen, N. V., Apeldoorn, The Netherlands, a 1925 graduate of the Technical University at Delft.

Joseph A. Henderson, Sales Engineer, W. W. Henderson & Sons, Pensacola, Fla. Attended the University of North Carolina.

Sten T. Hendriksson, Chemist, Boliden Mining Co., Skelleftehamn, Sweden, a 1941 graduate of the Royal Institute of Technology.

Harvey B. Herman, Chemist, Seymour Paper Mills, Inc., Seymour, Conn., a 1952 graduate of Western Michigan College.

Edward Jahoda, Chemist, H. P. Andrews Paper Co., New York, N. Y., a 1926 graduate of the University of Vienna with a Ph.D. degree.

Harold L. Keaton, Chemical Engineer, Gaylord Container Corp., Bogalusa, La., a 1948 graduate of Louisiana State University.

Howard Lane, Chemist, National Biscuit Co., New York, N. Y., a 1952 graduate of Long Island University.

Ehrhard H. Lenz, Student, University of Maine, Orono, Me.

Cecil E. MacDonald, Assistant Control Superintendent, Canadian International Paper Co., Ltd., Three Rivers, P. Q., Canada, a 1946 graduate of McGill University.

Minoru Machida, Chief of Technical Dept., Yonago Mill, Nippon Pulp Industry Co., Ltd., Tottori Pref., Japan. Attended the Train School of the Government Printing Bureau of Japan, Faculty of Papermaking.

Francis H. Maddox, Managing Director, Harland Drive Ltd., London, England. Attended Manchester University.

Nick H. Mailhos, Superintendent of Power, Brunswick Pulp & Paper Co., Brunswick, Ga.

William E. Manring, Senior Technical Service Engineer, B. F. Goodrich Chemical Co., Cleveland, Ohio, a 1937 graduate of Wesleyan University.

Daniel A. Martinez, Research Chemical Engineer, Hudson Pulp & Paper Corp., Palatka, Fla., a 1952 graduate of the University of Florida.

Kenneth McClelland, Midwestern Manager, Engineering and Sales, J. E. Rhoads & Sons, Chicago, Ill., a 1934 graduate of the University of Chicago.

Robert J. Meyer, Development Engineer, B. F. Goodrich Chemical Co., Avon Lake, Ohio, a 1943 graduate of the University of Wisconsin.

Mahlon V. Molsberry, Chief Engineer, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., a 1924 graduate of Iowa State College.

Harold E. Oliver, Chemical Engineer, Staunton Div., Canadian Wallpaper Mfrs. Ltd., Toronto, Ont., Canada, a 1946 graduate of the University of Toronto.

Robert W. Petrie, Chemist, National Biscuit Co., New York, N. Y., a 1950 graduate of Hofstra College.

Robert H. Quick, Student, Institute of Paper Chemistry, Appleton, Wis., a 1948 graduate of the University of Washington.

Kenneth D. Reed, Manager, Mill Lubrication Dept., De Laval Sales & Service, Inc., Pittsburgh, Pa., a 1925 graduate of Northeastern University.

Milton A. Schreiner, District Manager, The Foxboro Co., Foxboro, Mass.

Henry J. Schroeder, Plant Manager, Container Corp. of America, Circleville, Ohio, a 1941 graduate of the University of Cincinnati.

Lyle B. Schueler, Sales Manager, Diamond Power Specialty Corp., Lancaster, Ohio, a 1929 graduate of the University of Wisconsin.

Lester J. Smith, Resident Manager, St. Regis Paper Co., Harrisville, N. Y., a 1923 graduate of the University of Wisconsin.

William R. Strickel, Chemical Engineer, Johnson & Johnson, Chicago, Ill., a 1942 graduate of Missouri School of Mines.

Arthur R. Taylor, Chief Project Engineer, Brown Co., Berlin, N. H. Attended the University of New Hampshire.

Harry G. Taylor, Jr., Assistant Chief Chemist, Rayonier, Inc., Fernandina Beach, Fla., a 1945 graduate of North Carolina State College.

Robert R. Tess, Student, Western Michigan College, Kalamazoo, Mich.

Donald E. Thornton, Student, Western Michigan College, Kalamazoo, Mich.

Abner A. Towers, Sales Representative, W. D. Taulman & Associates, Atlanta, Ga., a 1939 graduate of Massachusetts Institute of Technology.

Robert C. Walker, Student, Western Michigan College, Kalamazoo, Mich.

Albert W. Wilson, Editor, *Pulp and Paper*, Seattle, Wash., a 1925 graduate of the University of Washington.

George A. Wishart, Supervisor of Quality and Development, Paper Mills Div., Eastman Kodak Co., Rochester, N. Y., a 1931 graduate of the University of Rochester.

Irwin Wittick, Vice-President, W. L. Rives, Jacksonville, Fla.

William P. Zimmerman, Kraft Mill Tour Foreman, Potlatch Forests, Inc., Pulp & Paper Div., Lewiston, Idaho.

TAPPI Notes

A. J. Colville Aikman is now Chief Chemist, Wiggins, Teape & Co. Ltd., High Wycombe, Bucks, England.

S. I. Anderson, of the Hooker Electrochemical Co., has transferred from Niagara Falls, N. Y., to New York City as Assistant Sales Manager of the New York District.

John B. Canha, formerly of the Pierce Consulting Engineering Co., is now Pulp and Paper Mill Engineer for Chas. T. Main Co., Boston, Mass.

John B. Catlin is now Assistant Vice-President of the Kimberly-Clark Corp., Neenah, Wis.

Warren A. Chilson, formerly of the Curlator Corp., is now Technical Assistant to the Director of Production, Champion Paper & Fibre Co., Hamilton, Ohio.

Harry E. Connors, of the B. F. Goodrich Chemical Co., has transferred from Cleveland, Ohio, to Boston, Mass., as Technical Representative for Plastic Materials.

James H. Davidson, Chief Engineer and Manager of Mill Operations for the Minnesota & Ontario Paper Co., has been transferred from International Falls, Minn., to Minneapolis, Minn.

John E. Donahue, Technical Service Engineer for the Hercules Powder Co., has been transferred from Kalamazoo, Mich., to Wilmington, Del.

John F. Donahue, Jr., formerly Student at the University of Maine, is now in the Technical Dept. of the Robert Gair Co., Uncasville, Conn.

Vance P. Edwardes attended a FAO conference devoted to the pulping of tropical and subtropical woods and other fibers, held in Rome, Italy, early in December.

Paul J. Frost, formerly of the New York & Pennsylvania Co., is now Assistant Pulp Mill Superintendent for the Oregon Pulp & Paper Co., Salem, Ore.

Mace Harris is now Consultant to the Manager of Manufacture of the Northwest Paper Co., Cloquet, Minn.

Alan B. Helffrich has transferred his paper sales business from New York City to 186 Shore Road, Old Greenwich, Conn.

Richard S. Hunter, formerly of the H. A. Gardner Laboratories, is now Director of Hunter Associates Laboratory, Falls Church, Va.

Eugene G. Ingalls, formerly of the St. John Pulp Co., is now Assistant to the Superintendent of the Felt Mill, Pabco Products, Inc., Emeryville, Calif.

John R. Kimberly is now Executive Vice-President of the Kimberly-Clark Corp., Neenah, Wis.

Howard J. Leech, formerly Student at The Institute of Paper Chemistry, is now Project Chemist for the Weyerhaeuser Timber Co., Pulp Div., Longview, Wash.

Stanley J. Leishman, formerly of the Escanoba Paper Co., is now General Superintendent for Provincial Papers Ltd., Thorold, Ont.

Andrew J. Luettgen is now General Superintendent of the P. H. Glatfelter Co., Spring Grove, Pa.

Gerald L. MacKinnon, of the Rogers Corp., has transferred from Goodyear, Conn., to Chagrin Falls, Ohio, as Sales Engineer.

Ernest Mahler, formerly Executive Vice-President, is now Director and Consultant for the Kimberly-Clark Corp., Neenah, Wis.

Edward A. Mason, of the Massachusetts Institute of Technology, has been transferred from Bangor, Me., to the Dept. of Chemical Engineering, Cambridge, Mass.

William S. Milne, formerly of the Publishers' Paper Co., is now Sales Engineer for the Black-Clawson Co., Hamilton, Ohio.

George E. Niles, formerly of the Monsanto Chemical Co., is now Consultant on Paper Problems, Emerson & Cuming, Inc., Canton, Mass.

Robert C. Paris has returned from two years' leave of absence for Naval duty to the Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., Research Dept.

J. R. Sethi, formerly of the Ballapur Paper & Straw Board Mills, Ltd., is now with the Choes Co., Ltd., Nagpur, India.

Ewald Schoeller, President of Ewald Schoeller & Co., has transferred his office from Zurich, Switzerland, to Langerwehi, Rheinland, Germany.

William P. Shannon is now Paper Mill Superintendent for Macon Kraft Co., Macon, Ga.

James F. Stevenson, of the Mead Corp., has transferred from Chillicothe, Ohio, to the Wheelwright Div. as Division Manager.

V. J. Sutton is now Mill Manager and Assistant General Manager of the Bowaters Southern Paper Corp., Calhoun, Tenn.

Louis B. Taylor, of the Columbia Southern Chemical Corp., has been transferred from Barberton, Ohio, to Pittsburgh, Pa., in the Market Research & Development Dept.

Milford J. Taylor, formerly of A. J. Adams Paper Co., is now Assistant Sales Manager of the Erving Paper Mills, Erving, Mass.

Joseph F. Teti is now President of the Specialty Covering Corp., New York, N. Y.

Vernon L. Tipka, formerly of the News Print Service Bureau, is now Assistant to the President, St. Lawrence Paper Co., Norfolk, N. Y.

R. Tourangeau, formerly of W. C. Hamilton & Sons, is now Manager of the Specialty Paper Mills, E. B. Eddy Co., Hull, P. Q., Canada.

C. B. Walworth, formerly of the Plaskon Div., Libbey-Owens-Ford Co., is now in the Research & Development Dept. of the Carborundum Co., Niagara Falls, N. Y.

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Nils Wegner, formerly of Hellefors Bruks, A/B is now Technical Director, Sanvikens Pulp Co., Dynas, Sweden.

A. D. Wolvin, of the Empire Box Co., has been transferred from South Bend, Ind., to Stroudsburg, Pa.

W. F. Woodzicka is now Engineer-Draftsman for the U. S. Forest Products Laboratory, Madison, Wis.

* * *

A. L. Magnuson has succeeded V. V. Vallandigham as the official representative of the Kelco Co., Chicago, Ill., in the Technical Association.

Industry Notes

Production

Production of wood pulp for 1952 through August was 10,936,000 tons, a decline of 156,000 tons under production for the same period in 1951. Wood pulp consumption also declined. At the end of August consumption for 1952 was 11,430,000 tons, 530,000 tons under the 1951 period. Imports of wood pulp were 1,180,761 tons, a decline of 471,101 tons. Imports from Europe declined 387,073 tons to 147,176 tons, and from Canada 1,272,789 tons to 1,033,581 tons. Wood pulp exports through August were 161,000 tons, an increase of 47,000 tons over the 1951 period.

Receipts of wastepaper for August was 629,000 tons increasing receipts for 1952, through August to 4,949,000 tons. The receipts were 1,809,000 tons less than the receipts for the January–August, 1951, period. Wastepaper consumption in August was 665,000 tons and for the eight months 5,033,000 tons, a decline of 1,466,000 tons under the 1951 period.

Pulpwood receipts for the January–August period totaled 18,322,000 cords, a decline of 4% under the corresponding 1951 receipts. Domestic receipts were 17,560,000 cords, a decline of 3%, while imports were 1,525,000 cords, a decline of 11%. Consumption of pulpwood for 1952 through August totaled 17,560,000 cords, about equal to the consumption for the comparable 1951 period.

Paper and board production during August amounted to 2,051,625 tons, a decrease of 7% over August, 1951. The industry operated at 73.5% (paper, 74.8% and paperboard 71.0%).

Wastepaper

Wastepaper consumption in the first eight months of this year amounted to 5,028,900 tons as against a consumption of 5,730,000 tons in the last eight months of 1951. The paper board mills consumed 76%, the paper mills 15%, and the roofing and building materials 9% of the January to September total for this year. While the national consumption of wastepaper in the first eight months of 1952 was 12.2% below that of the last eight months of 1951, the consumption by the building materials in the first eight months of this year was only 5.2% below the consumption of the previous eight months. The building materials mills in the first two thirds of this year consumed 469,721 tons of paperstock as against a consumption of 495,447 tons during the preceding eight months.

Operating at 96% of rated capacity, the nation's paperboard mills during October's second week set a new high production record for this year, according to the National Paperboard Association, when 245,680 tons of paperboard were manufactured. New orders for 236,589 tons were received during that week, leaving the mills with a backlog of unfilled orders for well over a half million tons at the beginning of last week, thus insuring the mills of high production and wastepaper consumption records for the rest of this month and into November.

North European Groundwood

The Swedish, Norwegian, and Finnish wood pulp pro-

ducers have reached agreement on a reduction of the output of mechanical wood pulp in order to achieve a better balance between demand and supply. The agreement applies to the remainder of 1952 and to 1953, and it is estimated that the reduction of output will lower stocks to a minimum by the beginning of 1953. The production of mechanical wood pulp planned for 1953 is 300,000 tons less than the 1951 production, but adjustments may take place later if the demand situation changes. At present, Swedish production of mechanical pulp is only 40% of capacity.

United Newsprint Mills

Plans have been announced for the construction of a newsprint mill in the Cincinnati-Dayton area, with an initial capacity of 100 tons daily. The company would be incorporated as the "United Newsprint Mills." The plant is expected to be completed by late 1953 and is to cost $6,500,000. In order to meet the needs of eight daily newspapers in Cincinnati, Dayton, and Columbus, it is planned in time to increase the mill's daily capacity to 200 tons.

Tree Farms

The October report of the American Forest Products Industries states that there are now 3918 tree farms, covering 26,652,223 acres. Alabama has the largest number of tree farms, 420, covering 2,608,377 acres, while Texas has the highest acreage, 3,213,190 acres on 409 farms.

Ireland Mill

According to *Foreign Commerce Weekly* of October 13, a new paper and carboard mill is planned at Grannagh, Ireland. The mill will initially produce 200 tons of large cardboard containers and 400 tons of cardboard a week, production to commence early in 1953. A wastepaper company of Cork City, a subsidiary of the Company, has begun a nationwide wastepaper collection drive, with the aim of collecting 250,000 tons of wastepaper for stock for the new mill.

Southern Pine Trees

The pulp and paper industry in the South has purchased and been responsible for having planted 277,000,000 pine trees during the past five years. This planting activity by the pulp and paper industry has converted over 277,000 acres of worthless land into productive forests. About 201,000 acres were planted on lands owned by the pulp and paper industry and the remaining 76,000 acres on lands owned by individuals to whom the industry contributed the trees.

West German Mill

A new sulphate pulp mill is being built in the Mannheim-Rheinau area of Western Germany, which is planned for operation about 1956. Annual capacity is said to be 52,800 short tons of kraft pulp, to be converted into 26,400 short tons of board and 26,400 short tons of containers. Pulp mill requirements are estimated at 83,000 cords of pulpwood per year to be procured from pine waste of German sawmills and similar low quality woods, especially fuel woods.

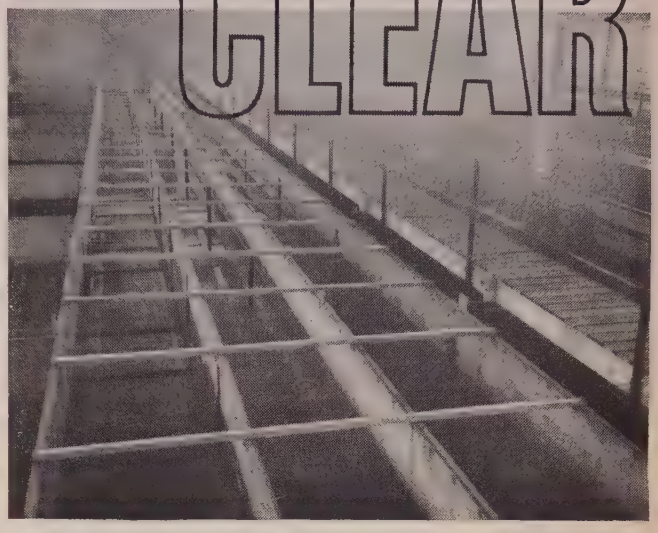
Bowaters

The entire output of the Newfoundland and East Tennessee Mills of Bowaters has been sold out for the next 15 years. Production potential in Tennessee is 130,000 tons and 50,000 tons of sulphate pulp. Contracts of the Corner Brook Mill in the southern United States have been transferred to the Tennessee mill. The Tennessee mill at Calhoun will begin production in 1954. Construction cost of the Tennessee mill is expected to be about 55 million dollars.

Spain

Paper production in Spain in 1951 amounted to 186,743 metric tons of paper and paperboard. Of this total 90,834

RAINY RIVER WATERS COME CLEAR



— for Minnesota and Ontario Paper

Rainy River water has color ranging from 40 to 80 ppm, making it unusable for bleached pulp and paper. The Minnesota & Ontario Paper Company successfully reduces color to a range from 2 to 4 ppm through use of two horizontal Permutit® Precipitators and five gravity filters. The cost for chemicals averages less than 1.5¢ per 1,000 gallons. The purity, low color and lack of turbidity make the effluent water ideal for production of high brightness pulps and papers.

Here is yet another case where Permutit know-how and equipment have helped produce finer pulps and papers, regardless of the original state of the water supply. For full information, write to The Permutit Company, Dept. TAP-12, 330 West 42nd St., N. Y. 36, N. Y. or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

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- Higher production—lower production costs.
- More sales . . . bigger profits.

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The kind of clogging you get between the inner and outer wires of your cylinder molds means long, tedious, expensive work . . . when you depend on manpower to clean the molds. But today that job is no longer a manual operation!

Get Thorough Cleaning with One Man in Less than Two Hours

One man uses Magnus Pitchex, spraying the solution on the cylinder surfaces. Pitchex goes to work at once . . . the deposits in the areas first sprayed being loosened and ready for flushing out by the time the man reaches the end of a cylinder. When he has flushed the dirt away with a high pressure water jet, the mold is as clean as new . . . . even the 'way-down-in areas!

With manual cleaning, the materials used for the job will cost less than Pitchex—but since *one man* does the work of three or four in about one-fourth the time, you'll find your over-all cleaning costs cut by at least 75%!

They'll Stay Clean Longer, too!

The thorough cleaning Magnus Pitchex does insures much longer running time for a machine between cleanings than you get with manual cleaning methods. The deposits are virtually *completely* removed, instead of being only partly cleaned out, with residual dirt serving as a basis for fast build-up to the clogging state.

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tons were printing papers while 19,774 tons were of newsprint grade.

Packaging Specifications

The National Security Industrial Association, 110 William Street, New York 38, N. Y., advises that industry's main problem with military packaging requirements is a lack of uniformity. As a result of the Association's efforts the Departments of the Army, Navy, and Air Force have issued a manual entitled "Preservation, Packaging and Packing of Military Supplies and Equipment" (TM-38-230, NAVEXOS P-938, AFM 71-1). It is the feeling of the Association that this manual should accomplish much toward assisting those in industry levels having the physical packaging job to do, in arriving at the proper type of pack specified in a contract.

Certificates of Necessity

Under the Defense Production Administration program certificates of necessity for tax write-off cover to date 135 applications, amounting to $735,011,000 or 3.2% of the total for all industry. As of September 5, 30 applications were pending, amounting to $40,250,000 or 1.2% of the total pending for industry.

Machine Coating Patent

Federal Judge Robert E. Tehan in Milwaukee, Wis., has ruled that the Kimberly-Clark Corp. did not infringe on the paper machine coating patent of the Consolidated Water Power & Paper Co. and that the patent is invalid. The trial ended on March 10, 1950, and has been taken under advisement in the period up to the present. The infringement as charged by Consolidated covered 1940 to 1950 when the patent expired. Since the patent had expired the question before the Court was that of damages.

Judge Tehan said that the Massey process was not an invention over prior art and did not constitute something new and useful. It, therefore, should not have been accepted by the Patent Office.

The process was developed by Peter J. Massey. The original coater was put in use at the mill of the Bryant Paper Co. in Kalamazoo, Mich., in the Fall of 1953. In 1933 it was installed by Consolidated. Meanwhile, Judge Tehan pointed out that Consolidated began to use the G-K process, employing a pair of applicator rolls without the use of brushes, similar to the Massey process.

Judge Tehan stated "Although the plaintiffs claimed it was one of the greatest inventions made in the industry they showed no unusual concern or apprehensiveness either in January, 1940, when they learned that Kimberly-Clark was going to build a paper machine to make an improved type of direct coated paper, or in December, 1940, when they had analyses made of the defendant's paper."

The patent referred to is U. S. No. 1,921,368. Consolidated is filing notice of appeal to the U. S. Circuit Court of Appeals for the 7th Circuit. They hope to have a decision from the Court of Appeals before next Summer. Unexpired patents of Consolidated dealing with the machine coating process in license agreements with companies using the Consolidated process cover machinery used, the coating composition, and other details.

New Zealand

The Muruopara pulp and paper project, now being put before the House of Representatives in New Zealand is intended to become that country's fourth largest industry, following dairying, meat, and wood. The industry will exploit the Kaingarao, the world's largest man-made forest.

Keyes Fibre

Ralph M. Westcott has been appointed Purchasing Agent for Keyes Fibre Co., Waterville, Me.

Western Michigan

The TAPPI Kalamazoo Valley Section has presented a loan fund of $1450 to the Western Michigan College, Kalamazoo, Mich. The Section stipulated that the fund be used for loans to needy and deserving students who intend to enter the paper industry.

Ammonium-Base Patent

U. S. patent no. 2,596,241 on ammonia-base recovery has been issued to Don Helleur, Kenogami, P. Q., and assigned to Price Bros. & Co. Ltd. The patent is concerned with an ammonia-base pulping cyclic heat and chemical recovery and is related primarily to sulphite pulping.

Aries

R. S. Aries & Associates has established a Detroit branch office at 15336 W. Warren Ave., Dearborn, Mich. R. A. Willingantz, formerly of the Union Carbide & Carbon Corp., will be in charge.

Paper Trade Terms

"Paper Trade Terms," 3rd ed., by William Bond Wheelwright has been issued by Callaway Associates, 172 Summer Street, Boston, Mass. (75 cents). The 3rd edition defines 747 terms common to the paper business.

Gulf States

The Gulf States Paper Corp., Tuscaloosa, Ala., is making a $2000 fellowship available at the Alabama Polytechnic Institute in honor of the Company's founder, H. E. Westervelt. One of these fellowships will be awarded each year for graduate work in forestry. The Company makes available four freshman scholarships in forestry, each with a value of $250.

M-C & S

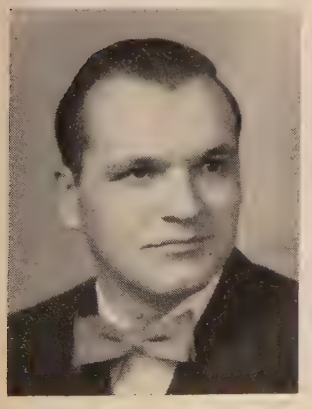
E. Walter Hammer has been appointed Manager of the Industrial and Building Constructions Div. of Merritt-Chapman & Scott Corp., New York, N. Y. He was engaged in the construction of the Southland Paper Mills at Lufkin, Tex.

Mead

James F. Stevenson is now Division Manager of the Wheelwright Div., Mead Corp., Leominster, Mass. Mr. Stevenson joined the Mead organization in 1943 at Chillicothe, Ohio, as a research and development engineer.

Glatfelter

A. J. Luettgen has been appointed to the position of General Superintendent of P. H. Glatfelter Co., Spring Grove, Pa.



J. F. Stevenson, Mead Corp.

A. J. Luettgen, P. H. Glatfelter Co.

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The beautifully printed "slicks" know the importance of fine calendering for newsstand appeal. They insist on smooth, uniform surfaces to achieve beautiful four-color printing results.

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You just interchange the lower test plates in the GURLEY-HILL S-P-S Tester to convert it into an instrument for testing either smoothness, porosity or softness of any type of paper, by measuring a given air-leakage over or through the paper.

This 3-in-1 laboratory "assistant" is simple to operate, quick and accurate, and a real utility instrument where printing quality of paper must be reliably measured.

Bulletin No. 1400 describes the S-P-S Tester as well as other Gurley paper testing instruments. It's worth writing for today. W. & L. E. Gurley, Station Plaza & Fulton Sts., Troy, New York.

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WEYERHAEUSER

For the third time, Weyerhaeuser Timber Co.'s annual report has been judged "best in the building materials industry" in the *Financial World* yearly competition.

P.C.F.

Walter V. Wentworth, Vice-President of the Penobscot Chemical Fibre Co., Great Works, Me., resigned from active service on October 1 after 54 years of service. He will continue as a Director of the Company.

CHESAPEAKE

Ellis Olsson, President and Chairman of the Chesapeake Corp. of Va., West Point, Va., has retired and been succeeded by his son Sture G. Olsson as President.

NATIONAL PACKAGING EXPOSITION

The American Management Association will hold its 22nd National Packaging Exposition from April 20–23, 1953, at the Navy Pier, Chicago, Ill.

EVERETT'S 60TH YEAR

"Around the Horn" was the historical route of sea-going pioneers and it is "around the horn" that machinery came to make paper in our Everett plant just 60 years ago.

On Jan. 14, 1892, the whaleback, *C. W. Wetmore*, brought both the No. One and No. Two paper machines, together with digesters and the rest of the papermaking machinery around the horn and up the Snohomish River to the site of the paper mill in Lowell, where it was unloaded at the paper mill dock.

On June 29, 1892, a little over a year after the Company had been organized as the Puget Sound Pulp & Paper Co., the first paper was run on the machines. During the 60 years from that day to July 1, 1952, our mill has made a total of 856,128 tons of paper.

When the mill was first built, the little community of Lowell and the brand new town of Everett were separated by timber and logged-off lands and the connecting link was a single muddy road which had ruts one to two squaws deep. Most of the travel between the two communities was up and down the river.

In those days Lowell already was an old community by Pacific Northwest standards. As early as 1870 the town had a few scattered houses along the river bank, a hotel, and a saloon. The site where the mill now stands had long been recognized as a stop-over camping place for Indians going up the Snohomish and Snoqualmie Rivers, then over Snoqualmie Pass to the grazing land in Eastern Washington.

In 1877, during one of the last Indian wars in the United States, a party of Nez Pierce braves who had come over the mountains to ask the Sound Indians to join them in a drive against the white men, made this camp ground their temporary headquarters. Their efforts to enlist aid from the Sound Indians were unsuccessful and they returned home after arguing for two weeks.

The first mill buildings were of wood construction and it was not until the early 1920's that these were replaced by brick. The No. One and No. Two machines and a part of the old finishing room are in their original location, but the rest of the plant has undergone many changes, renewals, and replacements. The plant started as a soda mill. A sulphite mill was added, later abandoned, and at present the process used is a modified soda cook.

Spruce, cottonwood, and fir were the first woods used in the mill. No peeler blocks in modern plywood plants ever came rounder, firmer, or with clearer grain than those logged from Snohomish river bottom lands to feed the hungry appetite of the sulphite mill.

The cottonwood and most of the fir were received as cordwood cut 4½ ft. long, split, and peeled. The spruce blocks

were broken down to cordwood size by means of a vertical steam splitter. The blocks were upended by hand, shoved under the vertical cylinders, whose pistons were capped by the cross-headed axe, and the descending axe quartered the blocks in one blow. Sometimes the axe would stick and the splitterman would bounce the block up and down like a hen picking up wheat.

After the sulphite portion of the mill was abandoned, the fir and cottonwood cordwood were the main raw materials along with few fir wood logs which were broken down as the spruce had been until the early 1920's when some clean mill wood from neighboring sawmills was tested.

Mill wood proved quite successful in paper production and for many years a large portion of the fir pulpwood came from bark-free mill ends cut 2 ft. long and 2 or more in. thick. In 1939, the chipper was designed to manufacture chips from reject veneer sheets. The use of veneer chips for pulpwood has proved quite satisfactory and has expanded into the major source of our fir wood supply.

World War Two brought about a major change in the manner of delivering cottonwood for pulpwood. Up until 1942, cottonwood came in the form of cordwood. The cottonwood cutters would fell their trees along the river bottoms, cut them into lengths, and split the logs. But after Pearl Harbor, cottonwood cutters became practically nonexistent and the mill was forced to turn to cottonwood in log lengths.

Almost overnight pulpwood handling had to be drastically revised. Instead of car and truck loads of split and peeled wood, we began receiving whole logs. Ways and means had to be devised to unload, buck, peel, and split these logs. Many methods have been tried during the past 10 years. One of the later developments was the installation of a mechanical barker of unique design. The men call it "The Green Swede." This, combined with a horizontal steam splitter, converts rough logs to pulpwood without any of the back-breaking work which was required to produce cordwood in the old way.

Changes in raw materials used in the mill have been accompanied by changes in processes, in products, and in markets. Where Everett at one time had a large number of customers across the Pacific in China and other countries, our paper today principally serves the people of the Western United States.

During the past 60 years the town of Lowell has changed with the growth of the mill. Scarcely any of the original homes remain. Still standing is the Lowell Community Church, located across the street and a half block south from the main office. This church was built in 1892 and still forms the center of the religious life of Lowell.

The first people working in the mill lived in the old Lowell hotel, now torn down, in boarding houses or in the community's newest homes. Due to retirements, there are no longer examples of three generations—fathers, sons, and grandsons—working in the mill together, but there are many young men with us whose fathers are still employed and whose grandfathers helped build the reputation for fine papers which Everett has enjoyed throughout the years.

Everett Pulp & Paper Co. was part of several projects planned for the development of the Everett area, and the only one which survived to help support not only Lowell and Everett but a wide portion of Snohomish County.

All of us associated with this mill and its splendid history can take pride in the fact that 60 years of continuous operation have built a solid foundation for many, many more years of employment.

Jim Hayes, *The Simpson Lookout*
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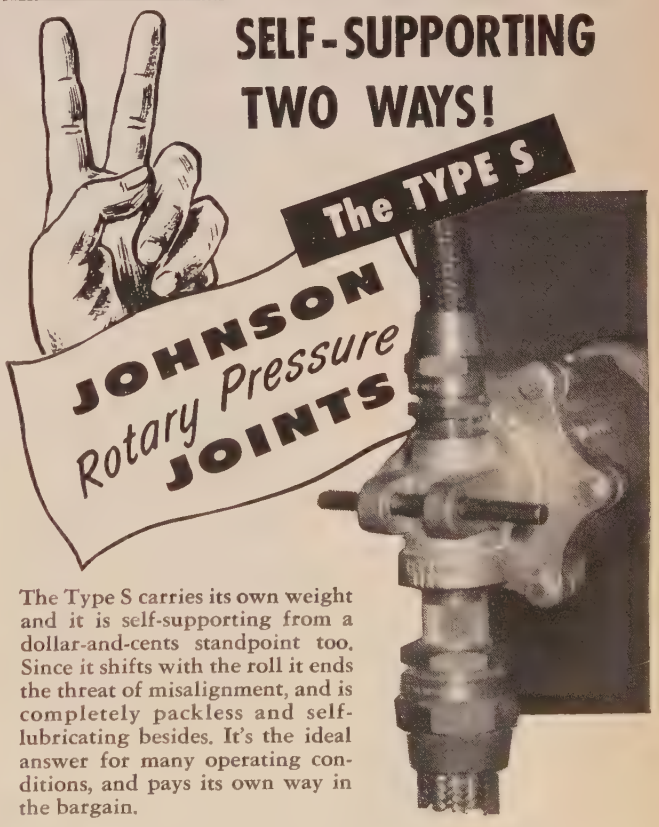

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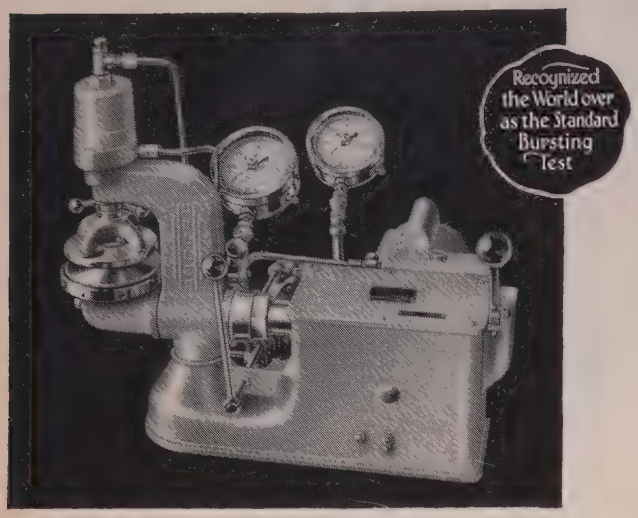

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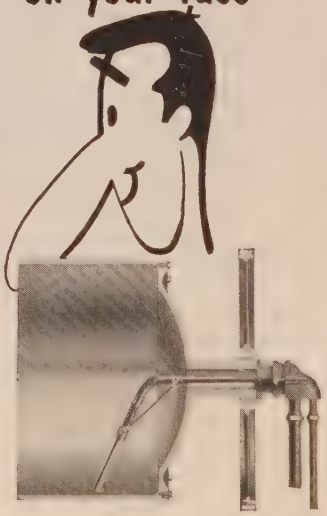

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ment have now been received after delays due to defense scarcities, and construction is going ahead rapidly on the last one of the new buildings that Northern Paper Mills is putting up in its project to reduce sulphite pollution in the waters of the Fox River and Green Bay. This final unit is a million-dollar boiler house that will give the mill capacity for burning as industrial fuel its spent sulphite liquor which previously had to flow into the stream.

Massive steel framework of the structure already towers 78 ft. above ground. Two huge drums totaling more than 100 tons in weight were suspended high in the steel frame this past week. Workmen will soon begin connecting these drums with dozens of boiler tubes 43 ft. long and $3^1/_4$ in. in diameter, and further units of the steam equipment will follow. Two huge fuel pulverizers, boiler feed pumps, fly ash collectors, and all of the boiler breeching already are on the site.

Bricklayers are scheduled to start enclosing the steelwork with masonry. Large openings will be left unbricked for several weeks at the lower levels to permit moving the huge boiler and furnace units into place inside the structure.

Northern Paper Mills already has waiting a building to house the stainless steel evaporators which will concentrate spent sulphite liquor to a density that can be burned. Also, all auxiliary equipment is on hand for the evaporators, and much of it is already installed. The evaporators were ordered 21 months ago and ever since have been awaiting release of the required stainless steel which is under strict federal control. Latest word from the fabricator is that the first part of this equipment will be shipped this month, with the rest following as rapidly as he can make and assemble it.

Union Bag

Installation of a new type electrostatic precipitator using a wet-bottom flow method instead of a dry hopper and con-

View of the five precipitators installed by the Research Corp. at the Union Bag & Paper Corp. plant in Savannah

veyor system for handling collected dust is near completion at the Union Bag & Paper Corp. plant in Savannah, Ga. Other precipitators used by Union Bag & Paper Corp. are dry hopper types and addition of a wet-bottom precipitator is their first of the new type. A wet-bottom precipitator eliminates dry hopper auxiliary equipment costs and speeds return of collected material to pulpmaking process. It was recently designed (patents pending) by Research Corp., Bound Brook, N. J., manufacturer of Cottrell precipitators.

The new precipitator at the Savannah mill will remove sodium sulphate from a spray-type black liquor recovery furnace handling 1,050,000 lb. of black liquor solids daily. Precipitator will clean 160,000 c.f.m. of gas at 275 to 300°F. with 90% rated efficiency.

Five were placed in operation to handle gases from nine recovery furnaces. These furnaces treat a total of 3,240,000 lb. of black liquor solids per day at full load, representing a pulp production of 1200 tons per day.

A sixth precipitator completed in 1950 and the new wet-bottom precipitator now nearing completion will clean gases from two spray-type recovery furnaces handling a total of over 2,000,000 lb. of black liquor solids per day, equivalent to a daily pulp production of 700 tons. All seven precipitators, supplied by Research Corp., will handle a combined volume of over 875,000 c.f.m. of gas on full load at about 275 to 300°F. with 90% rated efficiency.

Rayonier

John F. Hooper, associated for the past 12 years with the Rayonier Research Laboratories at Shelton, Wash., has been appointed Chief Chemist of the Jesup Div. of Rayonier, Inc., the chemical cellulose producer. In his new position at Jesup, Ga., where the company's new $25 million plant is under construction, Mr. Hooper will head up technical control operations. A University of Maine graduate, Mr. Hooper received his master's degree in chemistry at Washington State College in 1940. After a year with Lever Bros. in Cambridge, Mass., he joined the Rayonier Research Div. He is married and has one child.

Nekoosa-Edwards

The first experiment in the State of Wisconsin to alleviate the unpleasant odor from a kraft mill has been started at the Nekoosa mill of Nekoosa-Edwards Paper Co.

The chemical treatment was begun on a trial basis October 6. While definite improvement has been noted already in the mill and in the Nekoosa community, a decision as to whether the treatment will continue on a permanent basis depends on results obtained from the present 30-day trial period, as well as the cost and other factors.

The material used is a new product developed about a year ago by the du Pont company which was tailor-made for the pulp industry. It's called "Alamask P-3 Concentrate," and is a compound of synthetic aromatic chemicals.

According to J. C. Moertel, Odorologist and du Pont representative, the product does its job by "re-odorizing" or masking the obnoxious odor resulting from the kraft process. Moertel says the Alamask produces a "spicelike" odor when added in the proper proportions to pulp.

The procedure appears simple; a small quantity of Alamask (approximately 28 ounces to a 6-ton batch) is poured into the digesters immediately after chips are loaded. The compound is dissolved in the cooking liquor and thus goes through the entire pulpmaking and recovery systems.

A series of "snifter" tests are being conducted at various key points throughout the pulp mill during the 30-day trial period to determine what effect the Alamask is having on the familiar odor associated with kraft mills.

Moertel says the Alamask treatment is currently undergoing experimentation in several other mills. Estimated cost of the "re-odorizing" treatment for the Nekoosa mill is about

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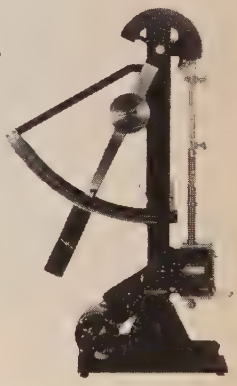

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WATERVLIET

Aerol Lifts, automotive transmission jacks such as used as standard equipment in garage repair shops, are helping to solve inspection problems in a Michigan paper mill. Watervliet Paper Co., Watervliet, Mich., has installed one of these hydraulic-powered units on each of 50 or more inspection tables to speed and simplify checking and sorting by making it possible to maintain paper stock at proper levels for the most efficient work operations. No change in procedure or equipment is involved beyond the adoption and use of the jacks to which simple wooden platforms, made by the paper company's carpentry shop, have been added.

The Aerol Lift installation at the Watervliet Paper Co.

As is customary throughout the industry, Watervliet stock to be inspected is piled high on a portable table that is moved into position before the inspector. To her left and right are other tables for approved and rejected sheets. In the past, problems have arisen due to the uneven levels of the three piles, particularly as her work progresses. Now, with the installation of an Aerol Lift below each Watervliet inspection table, the level of paper is controlled completely by the inspector who can raise or lower her table to the exact elevation she prefers, quickly and with virtually no effort. Adaption of this automotive service was accomplished at low cost merely by bolting a 2 by 4-ft. wooden platform or pallet made of two 12-in. wide planks to the cradle of each lift. The lift and platform are not attached to the table in any way, the size of the platform being large enough to carry and balance the load of table and stock evenly.

Aerol Lifts are made by the Automotive Div., The Cleveland Pneumatic Tool Co., Cleveland, Ohio, and are sold through automotive jobbers everywhere.

FINLAND

The basis of economic life in Finland is forest and the forest industry.

The value, in recent years, of production in the forest industry has been about a third of the total value of Finland's industrial production, the industrial labor employed more than a fourth of the total number of industrial workers. As, moreover, one day of factory work is calculated to require at least two in the forests, the supplying of the industry with raw material, i.e., logging, floating, and transport, is of prime importance as a provider of seasonal employment. Those who avail themselves of the opportunity are mostly small farmers, for whom forest cutting and hauling in the Winter, and even the Spring floating season, are a source of cash income. In the Summer they work on the land. The forest industry is further the biggest customer of the Finnish railways. The Finnish farmer, who owns half of

the country's forest, plans his investments in agriculture, from which about half of the population live, chiefly with an eye to what industry will pay for crude timber.

The clearest indication, however, of the position of the forest industry in the national economy, is that it supplies about nine tenths of Finland's exports. As metals, coal, petrol, chemicals, textile requisites, coffee, and other products which have at least so far not been discovered within the country or brought to grow on Finnish soil have to be imported, the Finns see in their forest industry the financer of essential imports and the determining factor in their standard of living. They call it the export industry, because about 80% of its output is shipped abroad. Because of the part it plays in the supply of raw materials from abroad for the other leading Finnish industries, the forest industry, which itself utilizes domestic raw material, indirectly influences the industrialization process as a whole.

In the picture a visitor to Finland gains of the country, the forest industry may not loom as large as, for instance, iron smelting in Belgium or shipbuilding in Norway. This, however, is in keeping with the tendency of the Finn to withdraw into his shell.

Though the share of the Finnish forest industry in world production is not large, the quantities it brings to the world market are of noteworthy dimensions. Thus, Finland's share in international trade in mechanical pulp and cellulose has latterly been about 20%, in sawn timber exports 15%, and in plywood exports 60%. As an exporter of newsprint Finland ranks second to Canada only. In exports of cellulose and sawmill goods Finland comes third after Canada and Sweden; in exports of fiberboard second after Sweden.

The Forest Resources

Finland is well qualified by nature for the development of a large-scale forest industry. Even the present forest area, 22,000,000 hectares, is the biggest in Europe after that of U.S.S.R. and Sweden. If we take the ratio of forest to total area, or the area of forest per inhabitant (5.1 ha. as compared with only 0.3 ha. in Central Europe), Finland leads. The number of tree species is not nearly as large as in countries farther south. But from the point of view of industrial exploitation of forest, this is an advantage. It facilitates the sorting of crude timber in cuttings. Meager soil and a relatively cold climate, again, tend to make the species used in industry, pine, spruce, and birch, grow in general straight and sparsely branched. Luxuriant and tangled forest of the tropical type is unknown in Finland. And surely one reason for the good industrial qualities of Finnish wood is the light northern Summer night. The Finnish tree grows slowly, only during the season when night is hardly distinguishable from day.

Nature Transports

An essential element in the Finnish landscape is that provided by the waterway. "The land of a thousand lakes" is an understatement. The waterways are at the same time an important economic factor. The wood reaches the mills 70% of the way floated. This form of transport is economically advantageous for over part of the distance running water supplies the motive power. The Finnish waterways lie for the most in a north-south direction, along the line thus of the country's greatest length. As, further, the differences in altitude are small, the journey of raw timber from the forest to a factory on the coast may, even though begun as soon as a tree is felled, take as long as two years. The raw timber seasons on the way along the frozen waterways. Romanticized, timber floating—a branch thus of economic activity—is a favorite subject in Finnish fiction. Finland's Don Juan is the lumberjack on his raft or shooting rapids perched on a log. Nowadays, certainly, many a lumberjack has exchanged his boathook for the wheel of a motor truck, for the moderate snow covering and suitably

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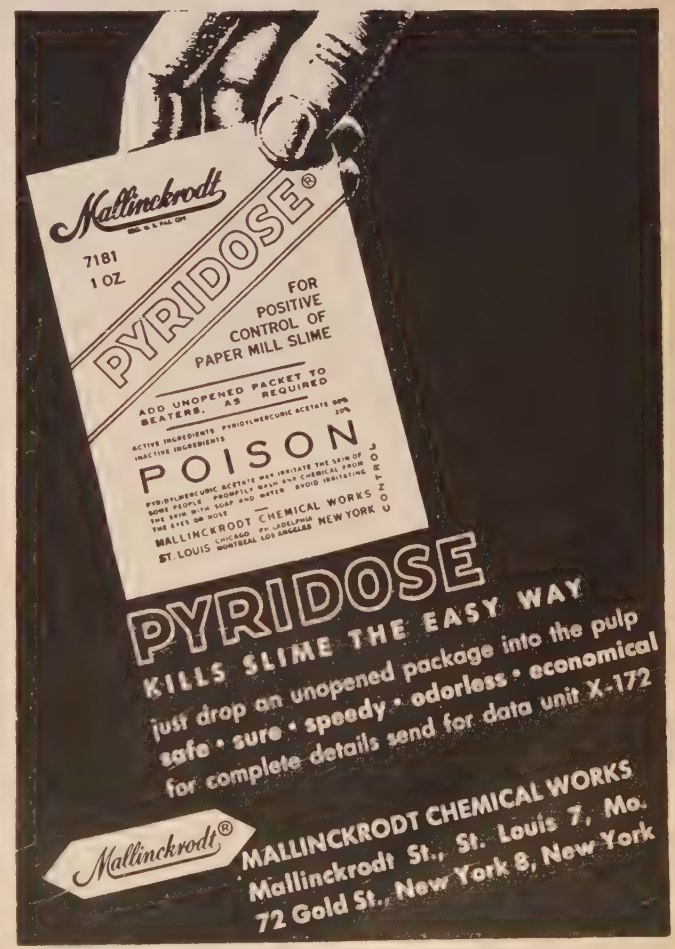
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The History

That a country with such forest resources should already in early times have utilized wood for other than domestic needs is only natural. In records Finland is mentioned for the first time as an exporter of round and shaped timber in the year 1433. Water-driven sawmills built in the 16th century chiefly to satisfy local demands for building timber were the forerunners of the Finnish sawmilling industry and already at that time enabled sawn timber as well to be sold abroad. Merchants in Turku (Åbo) are known to have sent a shipload of tar, boards, and laths to Amsterdam in 1551 in a convoy organized by Gustavus Vasa, King of Sweden who sought to liberate the North from the commercial ascendancy established by the Hansa League.

The first paper mill in Finland was built in 1667 on the initiative of the bishop then at the head of the Church to satisfy the need for Bible paper. For raw material, however, it used rags. The first mechanical pulp mill was founded in 1865, and already in 1867 Finnish pulp gained an award in Paris. The first sulphate cellulose mill was completed in 1880, and the first sulphite mill in 1885.

On these basic industries has arisen the present extensive and manifold forest industry, which on its mechanical side comprises, in addition to sawmilling, the manufacture of spools, plywood, and prefabricated houses, and on its chemical side, over and above the pulp industry, the manufacture of paper, board, converted paper and board articles, fiberboard, and cellulose by-products.

In spite of favorable natural conditions, the development of Finland's forest industry has by no means been plain sailing. At the time when Britain, in the first half of the 19th century, was moving toward free trade and timber from the Northern Countries was in increasing demand, the view was held in Finland that the real and only key industry for the country was iron manufacture and corollary industry. The forests had to be reserved as a source of charcoal for iron manufacture. Wood was needed also for tar distilling, the most important subsidiary occupation of the farming population. Sawmilling was fettered by various restrictions. When these were repealed in the second half of last century, opinion veered in another direction. Forest capital was regarded as representing a fixed amount of wealth which could be realized once for all for a fixed sum of money. The forests could therefore and should be cut down to make way for crop cultivation. There were, however, energetic pioneers of the forest industry who strove valiantly on behalf of their conviction that Finland's economic future lay in the proper utilization of her forest resources. And men appeared in growing numbers to carry on their work. Only by far-sighted planning and the carrying out of plans in the teeth of prejudice has complete economic exploitation of the country's natural raw material been achieved.

The Last 20 Years

The peak period so far of Finland's forest industry falls in the 1930's. Manufacturing capacity and production expanded especially in the pulp and paper industries. Technically, industry was on a top level. War cut short this phase.

After the war a new start had to be made with diminished raw material resources, reduced capacity and worn machinery. Nevertheless, in extremely unfavorable economic conditions reconstruction was carried so far, partly with the aid of foreign loans, that by overburdening machinery production figures were achieved in 1951 exceeding the level of the late 1930's.

Following calculations of the national forest resources covering the whole, those in the far north as well, and taking into account the effects on growth of extensive forest improvement works, plans have been drawn up for increasing the capacity of primary forest industry and, of course, further advancing the stage of manufacture. In regard to the former the old maxim has been applied: Forest is not a mine to be quarried once. It must be allowed to yield again and again.

An Industrialization Committee appointed to deal with Finland's industrial problems and consisting of representatives of the government and industry and technical experts, which after sitting for two years published its report at the end of 1951, recommends the raising of the production capacity of some branches of the forest industry, with due regard to raw material supply and financing possibilities, to above the prewar level. If these plans can be carried into effect, Finland's forest industry would enter on a new phase of expansion, steeper even than in the 1930's.

Sawn Goods

At present there are, in round numbers, 850 sawmills in Finland, of which 40 with a capacity of 5000 standards and of these 20 with a capacity exceeding 10,000 standards. The peak output, 1,494,000 standards, was in 1927. Exports in that year were 1,283,000 standards. In 1937 output was 1,368,000 standards, and exports 1,027,000 standards. The 1951 figures were: output 1,055,000 standards, exports 875,000 standards. The biggest buyers were the United Kingdom, Holland, Denmark, the U.S.S.R., the German Federal Republic, the Argentine, Belgium, South Africa, Eire, and Poland. The share of planed goods in the total has varied between 10 and 20%. The Industrialization Committee recommends an increase of 50,000 standards in sawmilling capacity.

Spools and Bobbins

The first spool factory in Finland was founded in 1873. Now there are 7 factories. The biggest output, almost the whole of which was exported, was 6800 tons in 1925. As late as 1937 output was 6400 tons and exports the same. In 1951 output and exports were 3500 tons. Buyers were the United Kingdom, France, Belgium, Australia, the German Federal Republic, Holland, Eire, Egypt, Switzerland, Australia, etc. At their highest Finland's spool exports accounted for nearly 90% of the world export trade in spools. The fall in output is not due to reduced capacity, but to a falling off in demand. Spool manufacture in Finland, it may be remarked, is to the extent of 99% export manufacture.

Plywood

The manufacture of plywood was begun in 1912. Since then the industry has rapidly expanded. There are now 18 actual plywood factories and 3 smaller plants turning out special plywoods. The peak production figure, 314,000 cu. m., is that for 1951. Exports in that year were 280,000 cu. m. Before the war the highest figures, for 1937, were output 258,000 and exports 228,000 cu. m. The biggest buyers in 1951 were the United Kingdom, Holland, India, the German Federal Republic, Denmark, Belgium, Sweden, Italy, Ceylon, and Egypt. In recent years Finland has been the world's biggest exporter of plywood: in 1951 about 60% of the world trade.

Prefabricated Houses

The prefabricated-house industry is a wartime development. The number of factories is 38. Output was highest in 1949 with 1,083,000 sq. m. of floor space. Of this 990,333 sq. m. was exported, of which 938,000 sq. m. to the U.S.S.R. In 1951 output was 980,000 sq. m. and exports 1,038,000 sq. m., of which 916,000 sq. m. to the U.S.S.R. Other buyers were Israel, the United Kingdom, the United States, Aus-

tralia, and Italy. Output has varied in proportion to deliveries to the U.S.S.R. In regard to building types and construction methods the industry is prepared to deliver buildings for any climate and any conditions. The industry has latterly absorbed 10 to 15% of the output of sawn timber planed.

Chemical Wood Pulp

There are in Finland 27 cellulose mills, of which 19 are sulphite and 8 sulphate. A semichemical pulp mill opened last year. In 1937, when output was at its highest, its distribution was as follows: bleached sulphite 322,500 tons, of which 83,500 dissolving, unbleached sulphite 720,500 tons, bleached sulphate 58,500 tons, and unbleached sulphate 379,500 tons, grand total thus 1,481,000 tons. The 1951 total was 1,386,000 tons or 93% of the previous peak. The quantity of bleached sulphite was 272,000 tons, of which 81,000 tons dissolving, unbleached sulphite 549,000 tons and sulphate 565,000 tons. No bleached sulphate was manufactured. Exports in 1951 comprised 70,000 tons of dissolving pulp (in 1937 81,000), 113,000 tons of bleached sulphite for papermaking (in 1937 235,000), unbleached sulphite 410,000 tons (in 1937 460,000) and sulphate 388,000 tons (in 1937 57,000 tons bleached and 302,000 unbleached). The ten biggest buyers in 1951 were the United Kingdom, the United States, France, the German Federal Republic, the Argentine, Italy, Poland, Denmark, Brazil, and Australia. The Industrialization Committee recommends an increase of 400,000 tons in the manufacturing capacity of the cellulose industries. Further, the bleaching of an additional 100,000 tons of sulphite, and the bleaching of sulphate up to 200,000 tons. Finland lost, be it remarked, her sulphate bleaching plant under the peace terms.

Mechanical Pulp

The output of mechanical pulp in 1951 was 807,000 tons, of which 210,000 tons were exported. Output and exports were at their highest in 1937, viz., 820,000 and 290,000 tons. The 1951 exports comprised 157,000 tons of wet pulp (dry weight) and 53,000 tons of dry. The biggest buyers were the United Kingdom, France, the United States, the Argentine, Belgium, the German Federal Republic, Holland, Australia, Spain, and Poland. The Industrialization Committee recommends an increase of 50,000 tons in manufacturing capacity.

Paper

Paper output was at its highest in Finland so far, 686,000 tons, in 1951, of which newsprint, wall paper, and novel printing paper accounted for 417,000 tons. The prewar peak, 664,000 tons, was in 1939. In that year the output of newsprint was 460,000 tons, so that the rise of 3% in output is the result of increased manufacture of other qualities, in the first place kraft. Kraft production was 78,000 tons in 1951, against 51,000 tons in 1939. Exports in 1951 comprised 380,000 tons of newsprint, 43,000 tons of kraft paper, 13,000 tons of greaseproof, imitation greaseproof, and vegetable parchment, 13,500 tons of M.G. pure sulphite paper, 5000 tons of M.G. mechanical sulphite paper (incl. Cap), 31,500 tons of woodfree printing (incl. M/G Poster), 53,000 tons of mechanical writing and printing paper, 1500 tons of tissue paper, and 4500 tons of cigarette, condenser tissue, carbon body, and other papers, or altogether 545,000 tons. There are now 8 newsprint mills and 19 other paper mills. The biggest buyers in this branch in 1951 were the United States, the United Kingdom, Denmark, Brazil, Australia, the German Federal Republic, France, Egypt, India, and Belgium. The Industrialization Committee recommends a joint increase of 350,000 tons in paper and boardmaking capacity.

Board

The output of board in 1951 exceeded, as in the case of paper, the prewar level. It totaled 205,000 tons, of which about one fourth was kraftliner. The highest prewar total, in 1937, was 156,000 tons. Exports in 1951 were 143,000 tons. The different qualities represented were: white machinemade board 8300 tons, folding boxboard 31,000 tons, cylindermade board 4000 tons, kraftliner 52,000 tons, and other special qualities 17,500 tons. Buyers included the United Kingdom, the German Federal Republic, Denmark, France, Australia, the Argentine, Holland, South Africa, Belgium, and the United States. The number of board factories is now 16.

Converted Paper and Board

The paper and board converting industry existed in Finland already in the 1920's. The real impetus, however, for a development of the industry, came with the war years. Now there are 9 large-scale converter enterprises. Products include paper sacks, bituminous paper, fruit wrapping and technical papers, paper fabrics, school exercise books and stationery. Production in the converter industry totaled 62,000 tons in 1951, of which 10,000 tons were exported. The biggest buyers were Israel, Italy, Denmark, the U.S.S.R., India, Australia, Greece, France, the United States, and Syria.

Wallboard

The latest comer in the branch of the forest industry utilizing mechanical grinding is the wallboard industry, which has been expanding since the war in regard both to the number of factories and to production. There are now 7 factories, and in 1951 these manufactured altogether 117,000 tons of fiberboard, of which 63,500 tons insulation board and 53,500 tons hardboard. Exports comprised 27,500 tons insulation board and 41,000 tons of hardboard. The biggest buyers were the United Kingdom, Denmark, Australia, the Argentine, Holland, the United States, Israel, Belgium, Colombia, and India.

By-products

The newest branch of industry, one developing and expanding, is the manufacture of cellulose industry by-products. In 1951 output included 27,000 tons of sulphite alcohol, 7500 tons of distilled tall oil, 3500 tons of distilled turpentine, 3000 tons of rosin, and 3800 tons of tall oil pitch. Exports in 1951 were 5300 tons. Buyers included Czechoslovakia, Denmark, Holland, Italy, Germany, South Africa, the United States, the United Kingdom, and France.

The Export Organizations

The first exporters of Finnish forest products were shipowners. Even after the middle of the last century the most important element in export trade in woodgoods was transport. Then, in the closing decades of the century the freighter pure and simple was joined in the care of exports by the importing and exporting merchant. However, in the measure in which forest industry plants developed and expanded they began to take the exportation of their products into their own hands. And especially after World War I producers formed export associations, which now represent an extensive export organization covering all of the most important branches of Finland's forest industry.

EBASCO

F. C. Gardner has been elected Executive Vice-President of the engineering, construction, and business consulting firm, Ebasco Services, Inc. K. W. Reece was elected Vice-President in Charge of Engineering and Construction. W. H. Colquhoun has been made Engineering Manager of the Company.

BASIC MATERIALS

An international exposition, first of its kind held anywhere, has been announced by Clapp & Poliak, New York, N. Y. It

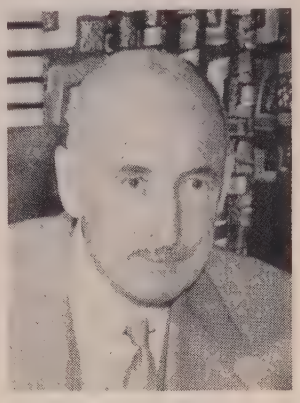
will be called the "Exposition of Basic Materials for Industry," and will be held at the Grand Central Palace, New York City, on June 15–19, 1953. It will feature new materials of all kinds from the laboratories of industry for industry. Details may be obtained from Banner & Greif, 250 W. 57th Street, New York 19, N. Y.

Instruments Training

The Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa., has just released a 60-page outline for the operation of an "Industrial Instrument Mechanic Training Course Outline." Copies are available at $1.50 per copy.

Lockport Felt

Lester J. Robinson, after 38 years of service as Administrative and Technical Consultant of the Lockport Felt Co., Newfane, N. Y., has retired.



L. J. Robinson, Lockport Felt Co.

Hooker

Thomas E. Moffit has been appointed Western Manager of the Hooker Electrochemical Co., succeeding Albert H. Hooker at Tacoma, Wash.

General Electric

The General Electric Co., Schenectady 5, N. Y., has issued a new bulletin on "Automatic Voltage Stabilizers" (GEA-5754).

G.E. has produced a new constant-frequency control designed to hold alternator frequency within 0.001% on motor-generator sets supplying up to 10 kw. of power. It was developed by the General Engineering Laboratory for industrial and laboratory applications where close frequency control is necessary. It is available in 50, 60, and 400 cycles per second standard in single or three-phase, and nonstandard frequencies are available on special order.

Ethyl

Louis M. Sherman has been appointed by Ethyl Corp., 100 Park Ave., New York 17, N. Y., Asssociate Director of Product Development in Charge of Industrial Chemicals.

Sandoz

Sandoz Chemical Works, New York, N. Y., has issued an interesting 60-page booklet on "Color and Instrumentation" by Edward W. Rhael.

Staley

The 1951 annual report of the A. E. Staley Manufacturing Co. has been judged best in the milling industry in a survey conducted by *Financial World Magazine*. Runners-up were the reports of General Mills, Inc., and Pillsbury Mills, Inc.

Westinghouse

R. H. Proctor has been named Manager of Manufacture of the Westinghouse Electric Co. In this position he will assist in guiding the activities of 40 manufacturing and repair shops maintained throughout the United States.

Ray H. Timmars has been appointed Manager of the Westinghouse Steam Div. at South Philadelphia, Pa.

Albert E. Lambert, Jr., has been named New England Manager of Distribution Apparatus Sales.

Westinghouse has issued a 20-page booklet on 30 applications of Industrial Turbine-Generators (B-5418) (Box 2099, Pittsburgh 30, Pa.).

The Westinghouse Sturtevant Div., Dept. T-415, 200 Readville St., Hyde Park, Boston 36, Mass., has issued a 12-page booklet on "Industrial Fans" (SA-6873).

American Brass

The American Brass Co., American Metal Hose Branch, Waterbury, Conn., has issued a 16-page booklet on "Flexible Metal Hose and Tubing" (catalog CC-400).

Reliance

The Reliance Electric & Engineering Co., 1088 Ivanhoe Road, Cleveland, Ohio, has issued a 4-page bulletin (F-2502) on Reliance M.-G. Sets.

Foxboro

The Foxboro Co., Foxboro, Mass., has issued three new data sheets on "Bin Level Control," "Storeroom Condensate," and "Temperature Recording."

Oliver-United

Dwight Richards has been appointed Director of Engineering of Oliver-United Filters, Inc., New York, N. Y.

Anheuser-Busch

Tate M. Robertson, Jr., has been appointed Sales Manager of the Corn Products Dept. of Anheuser-Busch, Inc., St. Louis, Mo.

American Polymer

G. S. Robins & Co. has been appointed Agent for the American Resinous Chemicals and American Polymer Corp. in St. Louis, Mo.

The American Polymer Corp., Peabody, Mass., has issued a useful data sheet on its product Polyer 426, an aqueous dispersion of a nitrogen-containing terpolymer.

Titanium Pigment

The Titanium Pigment Co. has announced the opening of a new sales office at 367 John St., N. W., Atlanta, Ga. Robert E. Noyes, formerly Sales Representative of the Cleveland office, will be in charge at Atlanta. Replacing Mr. Noyes in Cleveland will be Paul Eliot who has been transferred from the technical service laboratories in New York City.

Brown Instruments

The Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Station 64, Wayne and Windrim Aves., Philadelphia, 44, Pa., has issued a new instrument data sheet No. 292–1 on "Sulphate Digester Instrumentation 3."

Earl Paint

The Earl Paint Co., 240 Genesee St., Utica 2, N. Y., has issued a new 24-page catalog listing a complete line of coatings for industrial maintenance, including corrosion-resisting, insulating, waterproofing, and restoration materials.

Allis-Chalmers

Allis-Chalmers Mfg. Co., 828 S. 70th Street, Milwaukee, Wis., has issued a new "Guide to Centrifugal Pump Selection."

The Allis-Chalmers *Electrical Review* for the 3rd quarter 1952 includes the following articles: "Today's Power Plant Motors," "Dynamic Performance of Synchronous Generator Voltage Regulators," "Switchgear Drawings Clarified," and "Paralleling Load Ration Control Transformers."

Du Pont

The Boston and Providence sales organizations of E. I. du Pont de Nemours & Co., Inc., have been consolidated as

the New England District of the Dyes and Chemical Div. Robert R. Farwell and Harold L. Sager, Manager and Assistant Manager of the Providence District, have the same positions in the new organization.

Du Pont, Wilmington, Del., has issued an interesting 28-page booklet entitled "The Story of Safety."

CAMERON

The Cameron Machine Co., Brooklyn, N. Y., has begun the erection of a new plant in Randolph Township, N. J., to supplement its manufacturing facilities. The new plant will be a one-story building with a total area of 42,000 sq. ft. and will be used to make slitting and winding machinery. The plant is scheduled for occupancy about May 1, 1953.

LANGSTON

Samuel M. Langston Co., Camden, N. J., has purchased an adjoining property of 42,000 sq. ft. plus 48,000 sq. ft. of land adjacent to the building. Occupancy will be ready in 1953.

NATIONAL STARCH

Carlyle G. Caldwell has been elected Assistant Vice-President of National Starch Products, Inc. He has been Research Director since 1948. He is author or coauthor of many of National's patents.

OBITUARIES

Gustavus J. Esselen

Gustavus J. Esselen, Vice-President of the United States Testing Co., Inc., and Director of its Esselen Division in Boston, died on Wednesday, October 22, at his home in Swampscott, Mass.

Dr. Esselen was born in Foxbury, Mass., on June 30, 1888, and graduated as a Ph.D. from Harvard University in 1912. He was prominent in the field of chemical research for over 40 years. He was the founder of the Esselen Research Corp. which was merged with the U. S. Testing Co. in 1950.

Following graduation he was employed by the General Electric Co. from 1917–21. He was associated with Arthur D. Little, Inc., and in 1921 he became Vice-President and Director of Research for Skinner, Sherman & Esselen in Boston. In 1930 he established the Esselen Research Laboratories.

He is survived by his wife, Henrietta (Locke) Esselen, a brother, three children, and eight grandchildren. Funeral services were held at the First Congregational Church in Swampscott Cemetery.

Dr. Esselen was a member of the Technical Association of the Pulp and Paper Industry since 1930.

Thorwald A. Carlson

Thorwald A. Carlson, 59, nationally known packaging expert, died Oct. 24, 1952, at a Madison hospital. Carlson directed far-flung packaging operations of the military forces during World War II as chief of packaging research at the U. S. Forest Products Laboratory. He had been ill since midsummer.

A research engineer at the Laboratory for 31 years, Carlson specialized in packaging throughout his Laboratory career. In 1941, when lend-lease and military overseas shipping problems required great expansion of the Laboratory's research, he organized and assumed charge of a staff of experts that numbered, at the peak of World War II activities, more than 150 men and women.

Besides doing packaging research for the Army Air Force, Ordnance Department, Quartermaster General, Signal Corps, Corps of Engineers, various Navy Branches, the War Production Board, and other Government agencies, Carlson's staff visited manufacturing and shipping centers throughout the United States and abroad for special packaging consultation work. He headed a packaging mission to England during 1943.

Military experts have credited the Laboratory's work under Carlson's guidance with saving uncounted millions of dollars worth of war material such as food and clothing, ammunition, guns, vehicles, and aircraft from damage during shipment. It was estimated that by the end of the war packaging had been so streamlined and reduced in bulk that four ships could transport the equipment that earlier had required five.

When in 1950 the Nation's rearmament program began, Carlson enlarged his staff to handle military packaging and training problems.

Carlson, known to his many friends as "Tac," was a native of East Helena, Mont., where he was born July 21, 1893. For many years his father was a fruit grower near Yakima, Wash. In 1917 he was graduated from the University of Wisconsin as a chemical engineer and took a job as assistant chemist with the American Smelter and Refining Co. at East Helena. During World War I he served as an army chemist at American University in Washington, D. C., doing analytical work on test methods for new materials.

After the first World War he held a fellowship in metallurgical research at the University of Utah for a year. While there, he met and married Mrs. Carlson. He then held research positions with the Anaconda Copper Co. and the American Smelter and Refining Co. before coming to the Forest Products Laboratory in September, 1921.

During the years before World War II, Carlson often was the Laboratory's only full-time packaging specialist. He worked extensively on design and testing of both wood and fiberboard containers. In 1926 he was granted a public patent for the Carlson Score Tester, a device for testing fiberboard containers. He also developed methods of determining the causes of damage to packaged goods during shipment, and prepared specifications for various kinds of containers.

One of his lifelong objectives was to convince container manufacturers and users that many kinds of woods are suitable for the purpose. Often he found strong prejudice against any but a few kinds of wood in certain parts of the United States. By means of extensive tests and by writing about his findings for technical and trade journals, however, he succeeded in bringing many kinds of wood into use and thus helped to broaden the base of container wood supplies when demand became heavy during wartime.

When World War II ended, many of Carlson's staff went into private industry as packaging specialists. To keep them in touch with research developments, however, Carlson was instrumental in organizing them into a packaging club that has met annually in Madison since then.

At the time of his death Carlson was chairman of the committee on shipping containers of the American Society for Testing Materials. He has also served as a member of the Container Testing Committee of the Technical Association of the Pulp and Paper Industry. He held memberships in the Forest Products Research Society, the Society of American Foresters, scientific fraternity Sigma Xi, and the Madison Technical Club. At one time he was also a member of the technical committee on packaging of the Federal Specifications Board and chairman of its subcommittee on cushioning.

Besides Mrs. Carlson, the survivors are a son, Henry L., and daughter Margery.

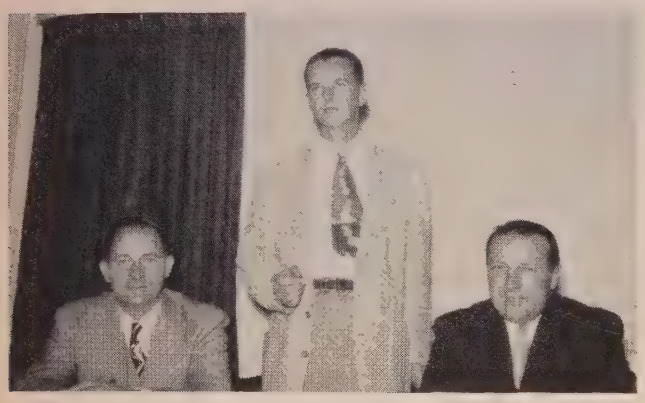
LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Empire State

Western District

Frank Forsyth of Wood Conversion Co. spoke before 45 members of the Western District, Empire State Section, Wednesday night, Oct. 1, 1952, at the Prospect House. His topic was "The Manufacture and Use of Insulating Board Products in the Building Trades." He was introduced by Gordon K. Storin of Niagara Alkali Company.



Francis Webster; Frank Forsyth, Wood Conversion Co., Speaker at the Western District, Empire State section meeting; and Gordon Storin, Niagara Alkali Co.

He spoke about the various requirements of insulation and how wood fibers are modified and treated to fill these requirements. He discussed experiments on the insulation of buildings with these materials carried on by the University of Minnesota. Mr. Forsyth's talk was followed by a 20 min. color movie on the subject of insulating board.

Metropolitan District

The Metropolitan District held its first dinner meeting of the season on October 14 at Fraunces Tavern, New York City, with about 80 members and guests in attendance. The chairman, Paul L. Haggerty, George La Monte & Son, Nutley, N. J., introduced the officers: Ralph Kumler, American Cyanamid Co., Vice-Chairman, and John Doherty, Union Bag Paper Corp., Secretary-Treasurer. Chester A. Landes is Program Chairman, Patrick C. Palmaccio, Membership Chairman, and William R. Willets, Publicity Chairman with Lew R. Ayres, Edward F. Boyle, and John L. Rice members-at-large of the Advisory Committee. The Articles of Organization which had been mailed to the membership were approved.

Chester Landes introduced the panel of speakers who discussed "The Development of Specialty Papers to Capture New Markets": George C. Borden, Technical Director and Manager of Coating Department, Riegel Paper Corp.; Walter T. Cusack, Vice-President, Aldine Paper Co.; and Lawrence S. Tobias, Sales Engineer, International Paper Co. All the speakers showed many samples which graphically illustrated their talks. An abstract of Dr. Borden's talk (as summarized on the spot), as well as the talks made by Messrs. Cusack and Tobias, follow.

Development of Twisting Papers to Capture New Markets

Lawrence S. Tobias

I APPRECIATE the chance to talk briefly to you tonight on this subject because we at the International Paper Company believe that new uses for paper will become increasingly important in our plans for expansion. We are firmly convinced that if we are to prosper and grow we cannot depend alone on simply increasing the use of our present grades—as a larger population, for example, uses more wallpaper and more newspapers. We know we must also devote a fair portion of our time and money and effort to expand our industry by discovering and fostering new end uses for our products.

While you may believe that most new end uses for paper and board must be placed in the small tonnage category, I should like to remind you of the phenomenal success of the paper milk bottle. Prior to 1938 the paper milk container was still in the laboratory stages of development. In 1951, 35% of the 21 billion quarts of milk and cream consumed at the American table was packaged in paper. Such a tremendous development had—and will continue to have—an important effect on the entire paper industry.

Those of you who had a part in this development know that the most important single aspect of the whole story lies in

G. C. Borden, Riegel Paper Corp.; J. H. Doherty, Union Bag & Paper Corp.; C. G. Landes, American Cyanamid Co.; P. L. Haggerty, George La Monte & Son; W. T. Cusack, Aldine Paper Co.; L. S. Tobias, International Paper Co.; and R. W. Kumler, American Cyanamid Co.

the word "cooperation." It wasn't any one inventor, one paper company, one converter, one supplier, or one consumer that made the paper milk container a reality. It was instead a combination of them all—working together—cooperating—which finally led to success.

I'd like to tell you tonight about another development

LAWRENCE S. TOBIAS, Sales Engineer, International Paper Co., New York, N. Y.

which we at International and several other paper companies, and converters as well, believe has a promising future. Twisting paper, or spinning paper as it is sometimes called, has reached a significant position in our industry today, mainly because of the fine cooperation among the paper companies, suppliers of all types, and the converters. This is a rather special kind of paper which requires some special equipment to manufacture and, as we are rapidly learning, a very special brand of "know-how" to make successfully.

Twisting paper, as some of you probably know, differs basically from normal or standard papers in that we attempt during its manufacture to align the fibers as much as possible in the machine direction in order to obtain maximum tensile strength in the final twisted twine. These papers are produced in weights ranging from 10 to 100 lb. and they are made of a wide variety of pulps on both fourdrinier and cylinder machines. Their sizing characteristics run from those which are completely absorbent to those which contain the hardest possible sizing treatments.

Most commonly, these papers are shipped to the converters in large jumbo rolls running between 30 and 60 in. in width, and the first converting operation is to slit these rolls into narrow ribbons and wind the ribbons into what are called "cheeses" or "pancakes." The width to which the ribbons are slit depends, of course, on the size and diameter of the twine to be produced.

The cheese is generally mounted directly above the twisting machine, which is usually of a type very similar to that used in spinning cotton or jute—except that a wetting bath or tray is added for the purpose of dampening the paper prior to the point of twist which begins at the twisting die.

Subsequent converting operations consist of rewinding, drying, weaving, braiding, and so on.

While I have simplified these basic operations quickly, it might be wise to point out here that twisting papers have one particularly disconcerting and incorrigible characteristic which we as papermakers abhor. Try as we will, we are helplessly unable to fool our converter-customers! Even using every conceivable subterfuge we can devise, we are never successful in hiding a single defect in any of the paper that leaves our mill. There is seldom any difference of opinion as to whether twisting paper is good or bad. It either twists or it doesn't. And when you realize that every square inch of paper must eventually pass through the die of the twisting machine (this die in many cases is as small as 2 one-hundredths of an inch) you can see that a shive or fiber cluster or slime spot, hardly large enough to be visible, will invariably cause a break on the twisting machine.

For various reasons the sheet running over our paper machines insists, on occasion, in parting abruptly. We have found that these breaks usually occur while the mill manager is explaining the operation of the machine to a distinguished customer! And consequently we have tried to reduce the number of paper machine breaks by confining visitors to the manager's office. But we seem to be making progress very slowly.

These paper breaks must be spliced, and ordinarily on grades which are shipped to printers and coaters and so on, this splice causes the converter little more trouble than to be sure it is discovered in the inspection department, and the imperfect sheets withdrawn. But I think you can see what happens when we ship a 50-in. roll with a splice to one of our twisting customers. He experiences no particular difficulty when he slits the roll, and if he were cutting $^1/_2$-in. ribbons, for example, he ends up with a hundred cheeses—each with a splice and each splice exactly the same distance from the core. Since we have never been able to devise a splice which will run through the twisting die without breaking, there occurs at some precise moment in our customer's plant a bit of bedlam when 100 spindles break down simultaneously, as 100 double thicknesses of twisting paper try to force their way through a die only large enough to permit the passage of a single layer.

But we have made some progress with this paper and I'd like to tell you some of the uses in which twisting paper is now on firm ground and give you an idea of some of the new end uses we are planning with the cooperation of various suppliers, converters, and consumers.

One of the first fields in which twisting paper was successfully used was in the manufacture of automobile seat covers. All of you are undoubtedly familiar with these covers. They are generally made of light weight papers gayly colored and woven into an infinite number of attractive patterns. In order to meet extremely high standards for light-fastness, a good deal of time and effort goes into the color formulations of these papers, and it is also most important that the colors do not bleed or rub off. Here are some samples of a few designs which you probably have seen before.

Seat Covers

Along the same lines, floor coverings, automobile trunk linings, door panels, notebook covers, hand bags and linoleum backing are being fashioned with paper fabric. A few samples which show some of these end uses are the following: notebook, paper rug, two trunk linings, hand bag, and linoleum backing.

Woven in a coarser mesh, twisting paper is formed into serviceable bags. These bags carry cabbages, potatoes, oranges, corn, and several other food products.

Vegetable Bags

In this instance, there existed from the start the need for high wet-strength papers which would retain a good part of their strength even after continued soaking by wet vegetables and fruits, ice, and even rain. Were it not for the wet-strength resins available to us today, such bags as these would be extremely limited in their use.

The use of wet-strength resins serves another important function in twisting papers. As I mentioned before, the paper ribbon is invariably wetted on the twisting machine so that it will become soft and pliable and take the twist with less tendency toward spring back. It has been found that the use of wet-strength paper yields improved efficiency on the twisting machines and produces twines with higher tensile strength in both the wet and dry condition.

Rug backing twines are an important end use for twisting papers today. This market, formerly held entirely by jute, was opened to paper during the last war when the supply of jute to this country was cut off.

Rug, Spool, and Gray Cop

Though we have been at it for a number of years now, a development program for a better paper for this use is still under way. The requirements call for an extremely strong twine, light in weight and long in yardage with good uniformity, flexibility, and aging qualities. Paper is equal to, and in some cases surpasses jute for the end use, but the problems of flexibility and elongation, for example, are still occupying much of our development time.

Some years ago we became convinced that the standard laboratory testing equipment was far from adequate in our development work to make better twisting papers and as we attempted to gain a foothold in new markets. We found that the tensile, mullen, porosity, tear, and sizing tests on the base paper often gave us data which failed to correlate satisfactorily with twisting performance or twine characteristics. There seemed to be only one good way to determine whether a given paper would twist properly or not—and that was to twist it. For this purpose we installed a commercial twisting unit capable of producing twines up to an eighth of an inch in diameter, and we built and equipped at the same time an experimental twisting laboratory to help us attempt to solve some of the technical problems which we found were unique

to this type of specialty paper. While most of the results of the work done in this laboratory have led to valuable improvements in our present twisting papers, I believe you may be interested in a new development which seems to show considerable promise.

In our continued attempts to produce twines of the highest possible tensile and knot strength for general tying use, we began some time ago to see if it would not be possible to incorporate strands of glass yarn with the paper ribbon directly on the twisting machine. Glass yarn, as you probably know, possesses amazing tensile strength and flexibility, though it is somewhat low in knot strength and resistance to abrasion. Paper twines, on the other hand, compared with glass, are low in tensile but their knot strength runs as high as 90% in some cases. We reasoned, simply, that if we were able to capture the sums of the two tensiles, we'd really have a twine on which we could hang our hat. In our first attempts, we took a paper which we knew would yield a twine tensile of 9 lb. and a single strand of glass yarn with a tensile strength of 4. It would seem that by properly combining these two on the twister, we should end up with a twine with a 13-lb. tensile strength. *But* we certainly did not. Our first attempts showed a twine of 9.5 lb., and one year and several hundred tests later, we had reached a figure only slightly higher than 11. With the help and cooperation again of several suppliers, and after certain changes in the base paper, we were finally able to achieve a tensile strength of 13 lb. on this twine—and we have since carried this work on to produce larger twines with tensile strengths in excess of 100 lb. While we may not have a development here to compare in magnitude with the paper milk bottle, we may at least be able to help the glass companies regain a part of the business we replaced with paper.

Summing it all up, it is interesting to note some of the markets which twisting paper has entered and some of the materials which it has, at least in part, replaced. Automobile seat covers, for example, made of twisted paper have replaced cotton, sailcloth, leather, and even mohair—as in the small Kaiser automobile which for reasons of economy, used fiber seat covers directly over the muslin. Paper trunk lining materials, as in the new Fords and Plymouths, have replaced rubber mats and imitation leathers. The paper mesh bag has replaced burlap, and the paper rug backing twine has caused jute to yield its exclusive position in the rug industry. Some of our paper and glass twines will do the same job now done by sisal and hennequen. The markets are there. All we have to do is go get 'em!

Specialty Papers (Abstracted)

George C. Borden

In the development of specialty papers the ideas may be obtained from: The research, development, and operating departments, the sales department, suppliers, and customers.

Although ideas from the first three sources may frequently result in the development of useful and profitable commercial products, the most important source of new ideas is usually the customer.

It is frequently possible to develop an interesting specialty paper using a new raw material or additive but if no customer can be found who wants the specialty it is bound to be unprofitable.

In developing a specialty paper a sufficiently large market must be available to make its manufacture profitable. It would be uneconomical for a paper mill to develop a specialty paper for which there was such a limited demand as to make it unsuitable for the mill's operating schedule.

If a sufficient market is available, some mill in the industry can be found to develop a paper to meet any specifications desired. However, it is essential that the end use requirements be definitely known.

Recently a converter sent in a request for a specialty type paper, but was very vague on the end use. In such a case it is very difficult to develop a paper because usually a compromise between the stated properties desired must be made. After some discussion the customer stated that they wanted to develop a disposable paper pad for cleaning toilets. The pad had to contain a soap, a disinfectant, and a perfume. It had to have enough water resistance to clean the bowl, but it also had to break down in about 45 sec. so it could be flushed away without clogging.

The market for such a product, if successful, seemed very large, so a great deal of research was done in developing it. However, when the product was almost ready for production the converter company decided they wanted the paper creped. Since the mill which did the development did not have creping equipment, and it would be uneconomical to install it for just one job, the customer placed the order with another mill.

Another specialty paper developed was the noiseless popcorn bag. A great deal of discussion was had on the advantages and disadvantages of putting a greaseproof polyethylene coating on the inside of this type bag. It was finally decided that, by using a highly absorbent paper, the grease would be absorbed, there would be no noise, and the temptation of filling the bag with water and dropping it from the balcony would be eliminated.

A specialty paper was developed for blotting negatives, but because of the small demand for this grade it was uneconomical to handle and was therefore discontinued. This frequently happens.

Sometimes a consumer will want a property that has previously been one to be avoided—an example was the customer requesting curl in a laminated sheet in which the avoidance of curl had always been a serious problem.

The use of wet strength and plastic materials has produced a whole new field for specialty papers.

The future for the use of paper is constantly expanding and each paper company must look for new markets if they wish to expand.

Ed. Note: Dr. Borden illustrated his talk with many examples of the various specialties (reputably over 600) manufactured by his company and the above summary cannot begin to indicate the many interesting points made and demonstrated.

George C. Borden, Technical Director, Riegel Paper Corp., Milford, N. J.

Specialty Papers

Walter T. Cusack

In preparation for tonight, I found that at the end of the allotted fifteen minutes I had only started to cover the things I had in mind. Consequently, if I rush through this without adequate explanation and demonstration, it is only for the sake of expediency. Everything I say represents my own personal opinion, subject to considerable question and rebuttal. Our subject tonight is so full of negatives, avoiding them would be misleading, and I feel we should first understand the subject.

What are we talking about tonight? Our language gives us but one word "specialty." I define a specialty paper as anything that comes off a paper machine made to suit a particular known end use and controlled in one way or another for that particular known end use. This is the broadest sense of the word. Take for example a regular grade of paper made by one mill according to long established standards. A customer uses it for ticker tape. His orders are not filled from stock—they are made especially for him to all the established

Walter T. Cusack, Vice-President, Aldine Paper Co., New York, N. Y.

standards except for a bit more with machine tensile strength than ordinary and a close control on this factor. A specialty? Yes, according to my definition.

Contrast this with another paper used for this exothermic wave pad I have here. This pad is formed by heat sealing the paper to the foil backing. For one type of coated foil the paper must have heat sealing properties on one side—for another type of foil no thermoplastic is needed on the paper but it must have a surface that will permit the heavy load of vinyl on the foil to get a grip on it. In use, the pad is clamped around a mandril, consequently, the paper must not bulk too much or break under this strain. The powder within the pad generates heat when moistened with water—hence, absorbency and wet strength are needed. Upon such activation, steam must escape through the paper, otherwise it will balloon, blow up and break, or come apart at the seams dripping hot chemical on a person's scalp. Thus, high porosity is a must. Yet, controverting this, the fine powder within the paper cannot be permitted to sift through the pores. One way you look at it, a closed sheet is needed; and, another way, it must be wide open. Initial moistening of the pad is not enough to make it perform satisfactorily. The paper must have a certain water holding capacity to activate all of the powder and steam—not dry heat only, must result. Yet, under no consideration must it drip water onto a person's hair or scalp. A specialty? Yes! But, there is considerable spread in the matter of degree between this specialty and one that is just a slight departure from the ordinary.

With a subject so broad we must be careful not to include anything that doesn't belong. Many so-called specialties are improperly named. The papers are regular but the outlets are specialized. A company, or salesman, may specialize in the needs of the hosiery trade, retail jewelry stores, doctor's offices, or what have you. A substantial specialty business may be built on, say, examination table cover rolls to doctors. But, the paper is not a specialty (perhaps ordinary M G tissue), until a special skidproof examination table cover pad is devised with the end use in mind when it is manufactured.

How are specialties brought about?

1. Demand. "Look, Oscar, I know you're making Gadzooks Bond for 20 years, but you gotta do something for Acme-Allied Narrow Roll Paper Tape Company. Sam says we're nice guys and the tickets to the World Series were nice too, but the paper we ship gives too much breaking trouble. Can't you make up a special lot of Gadzooks with some extra oomph in it?"

2. Receptivity or Latent Demand. Not now using a paper for a given purpose, but use would develop if paper was available. "Look, Bill, you supply us with paper to use on a Stokeswrap machine to prepare packages holding three ounces of coffee. We sell it to the restaurant trade where Silex coffee makers are used. How about a paper to pack a pound of coffee on the same kind of equipment? We might do a job on this and want some sample rolls to try."

3. End Use Ideas. A photographer wants the results of his work as soon as he clicks the camera. If positives can be blotted to speed drying time, why not negatives? Why scratch negatives with a squeegie? Why fog them with chemical driers? Why not a paper? Such a product, known as Aldex Quick Film Drier, was developed. But don't get any ideas about me advertising it, because, you could not buy it if you wanted it! Inquiries that come in regularly are from people who purchased their last package three to eight years ago. You can't make money on that kind of turnover.

4. Manufacturing Ideas. A way is found to make paper out of glass fiber. What if it must sell for six or eight dollars a pound, there must be some use for it.

5. Axe to Grind Ideas. "I know you're lost, Charlie, if you stray north of 52nd Street, but J. H. says we gotta find some guy to put chlorophyl in paper, and you are elected."

These five points partially cover the origin of specialty papers. We must place high up on our list another very important instrumentality. This is promotional activity and it divides in two parts. There is the promoter or salesman, if you will, who seeks a second promoter. The first type of promoter is the mill, or mill representative sales endeavor. For example, a mill may have newsprint, which, when printed can be read under water. But, the mill does not want to go into the publishing business. It has to find someone who will publish a newspaper for mermaids in order to sell it's product. Second type promotion is point of sale, or use. Getting away from the ridiculous and down to facts, Dow Corning and Sight Savers is an example. Low cost production of the assembled product made a 10¢ retail lens tissue package possible, and promotion put a silicone treated specialty paper on every cigar and drug counter in the country. Any of the various steps in the development of silicone treated tissue are incidental to the capture of a new market through vision and promotion.

We must recognize too, that there are many handicaps standing in the way of specialty paper developments. Our existing methods of evaluation are, to a very great extent, dependent on trial and error. Furthermore, there is insufficient protection to warrant pioneering. Who is going to absorb development costs under such conditions? Too, papermaking is traditionally a business that shuns interruption in production, and it is difficult for management to break this tradition. From a sales standpoint too, there has to be good fortune to pay off on the time spent to bring a profitable specialty into being. Not only is there the matter of getting the item, making it properly, and putting it over involved, but with new problems in connection with it coming up all the time, it requires more than the normal postnatal care and service.

For purposes of further illustration to cover some of the points I have outlined, I show you a new product. It is a disposable vacuum cleaner bag, made of paper designed especially to function in a new type cleaner. The public has just been told about it although I have been acquainted with it for years. This bag is sealed to keep one from coming in contact with the dirt, and the machine actually shuts off and ejects the bag when it is full.

Some six years of effort have gone into the development of the paper used in the manufacture of this new bag. It was more than six years ago that the manufacturer was contacted. Some time later experiments commenced. And, the customer devised a dust arrestance tester. In this, papers of various sorts were examined to establish resistance to initial air flow, dust arrestance, back pressure build up after introduction of dust. A desired optimum was arrived at and a given furnish was tried at four different weights. These were checked and tested with handmade bags in cleaners—not the lab instrument, and not only for dust arrestance and back pressure, but also strength. Having established something tangible it became necessary to evaluate the part played by other fibers in various combinations and arrive at a means to control from within 15 c.f.m. per sq. ft. at $^1/_2$ in. water pressure the desired porosity of the paper. Wet strength entered the situation because some people do run cleaners through puddles of water. So effect on porosity and dust arrestance, strength, and flexibility of wet strength agents had to be studied.

In addition to meeting the requirements of the customer's cleaner, determinations became necessary to find out if the paper could be processed on standard bag making machines. Trial runs of paper had to be made, not only for the bag machines, but to find out if the paper machine results could be duplicated. In this a serious adhesive problem developed because adhesives absorb into the paper—don't remain on the surface to give it a bond. Fortunately, the adhesive people overcame this, but still up for consideration is treating the paper to make the adhesive problem less critical. At least

2 years of field testing delayed the final acceptance of the product, plus further delays to make the machinery needed to assemble this novel structure, and also waiting for the customer to determine the best time to place their product before the public.

The result of this tale is a specialty paper with written specifications applying to each measurable property. They reflect the trials and errors, the delays, the research. Now this story would not be complete if I did not tell you that our competitor is not having a bed of roses. His low price figure has been revised. But, in 6 months he has been able to copy our paper sufficiently well to get some of the business for which we worked 6 years.

Louis E. Georgevits, *Recorder*
Titanium Pigment Co., New York, N. Y.

Eastern District

The first meeting of the 1952–53 season of the Eastern District of Empire State was held Thursday, Oct. 16, 1952, at Milfranks Restaurant, Glens Falls, N. Y. One hundred and fifteen persons attended.

A panel discussion of "Consistency Control and Measurement" was presented by four manufacturers of consistency control equipment. E. J. Trimbey of Trimbey Machine Works, Glens Falls, N. Y., opened with a history of the development of the first consistency regulator which was put on the market in 1916.

Ray DeZurik, Chief Engineer, DeZurik Shower Co., Sartell, Minnesota, presented his ideas for successful consistency control.

A. J. Sloan, Pandia Inc., discussed the Brammer Consistency Controller.

Arthur Landesman, Pulp and Paper Application Engineer, Fisher and Porter Co., Hatboro, Pa., explained the operation of a revolutionary idea for controlling consistency with particular emphasis on the 0–2% range. This instrument is in the process of development and operates on an electronic principle.

A lively open discussion period followed with the panel members being subjected to many questions from the floor and from the other panel members.

R. E. March, Chairman of the Eastern District presided.

Northern District

Seventy-one members of the Northern District of the Empire State Section at the first monthly meeting of the 1952–53 season, held Thursday, October 9, in the Hotel Woodruff, heard Dean Emeritus Illick of the New York State College of Forestry speak on, "Making the Most of Our Natural Resources." One facet of our natural resources is the human being, and the human relations of Forestry is vitally important to the welfare of the community, he said. Dr. Illick stated that, "I find myself quite in accord with the famed and beloved Dean Christian Gaus of Princeton who recently stated that the central objective of education is *to build better human beings in a better world!*" He now teaches a course in Human Relations in Forestry at the New York State College of Forestry which is an outgrowth of his "My Boys" folder. Dean Emeritus Illick has an abiding confidence in the youth of the country. This confidence is reciprocated by the youths who affectionately address him as "Uncle Joe" and return to him in later years for advice.

Dr. Illick stated that about 6% of the timber in the New York State Forest Preserve is virgin timber. New York State is paying about $1.5 million dollars in taxes per year to the local communities in which the New York State Forest Preserve is located. This is considered to be a good policy because the tax payments help to stabilize the economy of the community.

During a discussion period Dr. Illick, in reply to a question asking how the States can get people to work and stay in the forests, feels that the modern day practices of forestry—

R. J. Murtaugh, St. Regis Paper Co.; C. D. Mather, Carthage Paper Makers Inc.; R. A. Premo, Gould Paper Co.; Dean Emeritus Joseph Illick, College of Forestry, State University of New York; J. H. Treadwell, Treadwell Supply Co.; and J. D. Parmele, St. Regis Paper Co.

mechanization whenever possible—no longer require men to stay in the remote sections of the forest.

Dean Emeritus Illick has a strong feeling for the continued prosperity of forestry and wood utilization and quoted President John B. Veach of the NLMA who, on May 8, 1952, in St. Louis, said, "I believe I can look forward in the lumber industry 20 years and see 50 per cent of our production in products of which we do not even dream today." "Perhaps at this very moment another derivative as great as rayon or cellophane is in the test tube."

"This harnessing together of rapidly advancing technologies in the laboratories and the mills and the improvement of cultural practices in the woods is ushering in the most dynamic and creative forestry program the world has ever seen." That's how Dean Emeritus Joseph Illick sees forestry today.

Richard J. Murtaugh, *Secretary*

Kalamazoo Valley

The Kalamazoo Valley Section held its first meeting of the 1952–53 season at the Hotel Harris, Kalamazoo, Mich., on Thursday, Oct. 2, 1952. About 120 were present.

The subject of the meeting was "Management's Views of the Technical Department." It was a panel type meeting, the main talks being given by George K. Ferguson, President, Watervliet Paper Co., and Maxwell Bardeen, President, Lee Paper Co. They were ably assisted by Fred Buchanan, General Manager, National Gypsum Co., James Wise, Vice-President, Kalamazoo Paper Co., Dwight L. Stocker, President, Kalamazoo Vegetable Parchment Co., and John Wood, Vice-President, Kalamazoo Vegetable Parchment Co.

The meeting was opened by the section chairman Thomas Luey, Sutherland Paper Co. The speakers were introduced by the Vice-Chairman Reginald Hurst.

Mr. Ferguson traced the development of technical departments in general from his experience. The technical department's duties at first were confined chiefly to testing, then advanced to development, which he defined as the adaption of known techniques to specific problems. Research he regarded as a pure dividend to management.

Testing is still of value, quick accurate information is needed badly, but development is of chief interest. He stated that creative imagination is the essence of successful development procedure, the difference between high and low rewards.

The challenge to the industry in the Valley is quality production at lower cost—this can be the work of the research staff as it has been in large mills in other areas. He thought of the technical department as a type of partnership in management.

Mr. Bardeen spoke also of the early days of technical departments of which he was a part. Of the association of the technical men with the Valley "Cost Group." Of the time

J. C. Wood and D. L. Stocker, Kalamazoo Vegetable Parchment Co.; J. A. Wise, Kalamazoo Paper Co.; G. K. Ferguson, Watervliet Paper Co.; A. T. Luey, Sutherland Paper Co.; R. H. Hurst, Kalamazoo Vegetable Parchment Co.; M. D. Bardeen, Lee Paper Co.; R. T. Trelfa, Watervliet Paper Co.; Fred Buchanan, National Gypsum Co.; and J. A. Dean, Michigan Paper Co.

when the chief problem of the technical department was getting along with the superintendent to the present acceptance as a valuable asset in the industry.

At present, management in the Valley, he said, looks to the technical department for control, development work, and, to a growing extent, research. Control covers the ground from the raw material to the finished product. He stated that, whether control should be responsible to operation or management was controversial; his thought was that it should be a source of information to operation, both being responsible to management.

Development running parallel to control is more spectacular and imaginative than control but control is the bread and butter part of the technical department.

The members of the panel concurred with the speakers and added that the technical man should consider the possibility of going into management and operation. Management does not wish to dominate the technical department but rather to furnish it with leadership. The chief chemist is recognized as one of the important members of the organization.

There was some discussion from the floor regarding the responsibility of control; it was reiterated that control should work with production, and it should not be regarded as a policeman. It was also brought out that the fact that the technical department in many mills has become a seed bed for top jobs in other departments is a compliment to the current technical leaders.

J. A. Dean, *Secretary*
Michigan Paper Co., Plainville, Mich.

Pacific

Four hundred superintendents, technical men, representatives of the Allied Industries, and their ladies attended the Western International Meeting of the Pulp and Paper Industry held on September 25–27 at the Empress Hotel, Victoria, British Columbia. Three different groups were associated with this international meeting—the Pacific Coast Division of the American Pulp and Paper Mill Superintendents Association, the Pacific Section of TAPPI, and the Pacific Coast Branch of the Technical Section of the Canadian Pulp and Paper Association.

After registration on Thursday, September 25, the opening technical session was held on Friday morning when M. F. Smith, Sidney Roofing and Paper Co., Ltd., who was the Convention Chairman, welcomed the guests to Victoria.

First Technical Session

J. Keith Eadie, McMillan and Bloedel Ltd., Port Alberni, British Columbia, acted as the Moderator at the technical session, where the "Conversion of Soft Crepe Tissues" at the Westminster Paper Co. and the "Refiner Studies" made at Pacific Mills, Ocean Falls, were discussed, and C. Christiansen reviewed the work of the Corrosion Project of the Canadian Pulp and Paper Association.

Paper Converting

Mr. McMillan outlined the manufacturing process for making one and two-ply facial tissues and napkins by showing the diagrams of the paper converting machinery manufactured by the Paper Converting Machinery Co. and the Hudson Sharp Machinery Co.

In his talk Mr. McMillan defined dry-creped tissue and described the manufacturing operation in detail. The speaker gave the raw stock quality requirements for ultimate use and compliance with consumers' demand for quality as well as the strength requirements for the converting operations.

In describing the converting operations Mr. McMillan showed the diagram of the equipment used to manufacture one- and two-ply bathroom tissues, two-ply facial tissues, and two- and three-ply napkins and serviettes.

In the conclusion of the paper, Mr. McMillan emphasized the stretch qualities for keeping the paper evenly stretched and also of using a shear-type slitter. At the same time the speaker said that the paper converting machines should be closely watched by the operator to get efficient results and suggested that major repairs on the machine should be scheduled well in advance. Finally, Mr. McMillan said that the uniformity of the raw stock was an absolute essential to ensure the efficient operation of converting machinery.

Kraft Pulp Refining

Mr. Symes read the paper prepared by him and J. A. Dawson, Pacific Mills, Ltd., on "A Mill Study of Kraft Pulp Refining."

The summary of this paper was as follows:

From results obtained by operating a single jordan at low throughput and at various applied powers, it is concluded that the most efficient power usage and Mullen development for a given freeness drop will be obtained by using a few jordans set well up. The most efficient tear development, however, will be obtained by using several jordans well backed off. Power efficiency in the latter case will be poor.

When operating three jordans in series at low throughput and at constant total power input, power efficiency was found to be independent of the power applied to each jordan. Mullen and tear strengths attained, however, were affected by the setting of the individual jordans.

The freeness drop and power efficiency obtained from two Hydrafiners operating in series were found to be dependent only on the total applied power and not on that applied to each refiner. The Mullen strength attained at a given total applied power varied as the setting of each unit was changed. Tear development, however, appeared to depend only on the total applied power.

A. M. Cadigan, St. Regis Paper Co.; L. M. Pumphrey, Westminster Paper Co.; R. B. Morden, Morden Machines Co.; Douglas Jones, Canadian Pulp & Paper Assoc.; and M. F. Oke, Vancouver Paper Box Co.

Two Hydrafiners operating in series showed more than double the power efficiency of six continuous beaters operating in series. The two Hydrafiners developed Mullen more efficiently but tear less efficiently than the six beaters. The Hydrafiner units reduced shives more effectively.

From a comparison of the refining action of jordans fitted with wide and narrow tackle, it is concluded that the narrow tackle gives more efficient development of Mullen and tear. Power expenditure is less for the wide tackle. These findings were confirmed by a review of paper test data.

In the range 1.9 to 2.9% consistency, strength development of a jordan operating at constant throughput can be improved by increasing the consistency, but only at the expense of power.

In normal operation, a group of three jordans in parallel, each at low throughput, gives more efficient Mullen development than two Hydrafiners in series at high throughput. Tear efficiency of the jordans, however, is slightly lower than that of the Hydrafiners, while power efficiency is approximately half. These differences appear to be a result of the wide difference in throughput for the individual units.

Data accumulated show that Mullen losses ranging from 20 to 40% are experienced from the machine service box to the dry end. This would indicate that studies of sheet formation, loss of fines, and drying might reveal how Mullen of the finished paper might be improved.

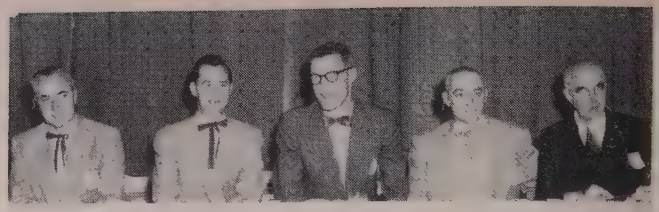
In this paper the authors reported on the studies made to establish the relationship between the refining variables and the finished paper quality by collecting operational data for the various types of refining equipment in actual mill operation in the manufacture of kraft pulp refining for three specialty machines at the Ocean Falls, British Columbia mill.

Mr. Symes presented a number of charts and diagrams showing the arrangement of the machinery and equipment and the flow of production on the three machines. The results of specific tests on beaters, Hydrafiners, and jordans were discussed in detail and a description of the ratio testing method used throughout the mill tests was included.

Digester Corrosion Studies

C. B. Christiansen, Corrosion Project Supervisor, Pulp and Paper Research Institute of Canada, showed a number of slides giving photographs made by the Task Force in the field work which included the instruction of 60 digesters in the Dominion of Canada. Mr. Christiansen said that besides himself and two other representatives of the Pulp and Paper Research Institute, two metallurgists with the Bureau of Mines at Ottawa were also available in connection with the studies. The speaker said that thirteen pulp and paper companies in Canada, which manufacture 90% of the kraft pulp made in the Dominion, underwrote the expenses of the studies. Mr. Christiansen mentioned the TAPPI corrosion questionnaire which will be reported on at the Engineering Conference at Chicago in October. One result of the corrosion studies has been the publication of a Digester Inspection Manual, which has been distributed through the supporting companies.

Mr. Christiansen said that the object of the corrosion study was to determine the causes of corrosion by analyzing the operation practices at the mills, by the analysis of the steel used in the digesters, and by cooking liquor analysis.



C. L. Walton, Simpson Logging Co.; G. Ostenson, Crown Zellerbach Corp.; J. K. Eadie, McMillan Bloedel; A. C. McCorry, St. Regis Paper Co.; and Professor K. Freudenberg, University of Heidelberg

In order to determine the composition of the steel, samples from the various digesters were taken including samples from digesters having low rates of corrosion, high rates of corrosion, and from discarded digesters. Mr. Christiansen emphasized the fact that while he had certain observations to make as a result of these studies, no final report was possible until the studies were complete. However the observations were of great interest to the Superintendents and Technical men at the Victoria meeting because of the widespread interest throughout the industry in the corrosion problem.

In the first place Mr. Christiansen explained the methods used in these field studies for inspecting the digesters by the use of portable gages which measure the thickness of the metal by means of an ultrasonic source of vibrations which determine thickness of the steel in the digester to within 3% of the total thickness. Another gage using a radioactive source is also used by being suspended in the digesters, but this is not used in the actual field work. Samples are taken from the digesters to study the steel corrosion and corrosion fatigue. New digesters have also been inspected to determine patterns of the defects in the steel.

As a result of this field study it has been found that when automatic welding has been used in the digesters the parts which have been welded corrode more rapidly than the rest of the digester, while on the other hand when manual welding is used the welded parts stand up as well as the rest of the digester. Certain patterns of corrosion have been found in the digesters, some of which were traced through the metal oxide scale used in the fabricating process. These mill oxide streaks of patterns are found on new digesters. One interesting result of the field study has been the conclusion that while natural cooking liquor scale on the digester can prevent corrosion, it is not possible to protect the digester surface completely in this way and consequently if only 10% of the surface is corroded, the digester is nevertheless injured. Consequently, natural liquor scale as a method of controlling corrosion is not effective. It was also found that deflector rings used on some digesters could not prevent corrosion but merely change the corrosion pattern from vertical to horizontal. It was interesting to note that the way the chips are piled in the digester results in a definite corrosion pattern, and the way the liquor runs down the walls of the digester is another cause of corrosion patterns.

At the conclusion of the talk there were a number of questions. One of these questions asked the best method for removing the mill oxide scale whether by using acid or by sand blasting, and Mr. Christiansen said that the sand blasting method was preferable. Asked regarding the difference in the quality of the steel used in digesters manufactured today as compared with digesters made a number of years ago, Mr. Christiansen said that this was now being studied but made the observation that it seemed likely that the old digesters were attacked by corrosion just as the present digesters are, but there was a difference in the corrosion pattern. In reply to another question Mr. Christiansen said that the field studies have shown that the greatest amount of digester corrosion occurred between $^1/_3$ and $^1/_2$ of the way down the digester. Asked whether moisture in the upper zone of the digester was one of the variables causing corrosion, the speaker said

S. E. Hazelquist, Weyerhauser Timber Co.; J. L. McCarthy, University of Washington; M. F. Smith, Sidney Roofing & Paper Co.; K. P. Geohegan, Howard Paper Mills, Inc.; F. J. Weleber, Publishers Paper Co.; C. B. Christianson, Pulp and Paper Research Institute of Canada; R. Patterson, Powell River Co.; H. C. Langston, Sidney Roofing & Paper Co. Ltd.; W. W. Clarke, Longview Fibre Co.; and H. A. Des Marais, Pennsylvania Salt Mfg. Co.

that this was now being studied as well as the oxygen factor. In conclusion Mr. Christiansen enumerated the various tests which were used in the analysis of cooking liquors.

Golf and Mill Visits

On Friday afternoon a golf tournament was held at the Victoria Country Club. A number of the visitors took the opportunity of visiting the Sidney Roofing and Paper Co. and British Columbia Forest Products Ltd. at Victoria. There was also a demonstration of the use of the Beta Ray Gauge for measuring paper thickness by T. L. Kelly and T. J. Slocum at the Sidney Roofing and Paper Co. Manufactured by Tracerlab Inc.

Twilight Cruise

On Friday evening there was a very enjoyable twilight cruise on the Canadian Pacific Steamship "Princess Joan" around the Gulf Islands in the Strait of Georgia. The beautiful city of Victoria, which is the capital of the Province of British Columbia, is located at the southern tip of Vancouver Island, directly opposite Port Angeles, Washington.

Wake-em-up Breakfast

Early on Saturday morning the International Brotherhood of Migratory Peddlers entertained at a Wake-em-up Breakfast with one of the famous skits which these members of the allied industries enjoy putting on for the amusement of their friends.

Second Technical Session

At the Technical Session on Saturday morning, A. Cadigan acted as Moderator. J. McCarthy of the Chemical Department of the University of Washington presented a paper, written by him and his two associates, V. F. Felicetta and Q. P. Peniston, on "Determination of Hydrogen Sulphide, Methyl Mercaptan, Dimethyl Sulphide, and Disulphide in Kraft Mill Process Streams."

The abstract of Mr. McCarthy's paper is as follows:

Mass spectrometer examination of the volatile components in the condensate from kraft pulp digester blow gas has confirmed the presence of hydrogen sulphide, methyl mercaptan, methyl sulphide, and methyl disulphide and has shown that corresponding ethyl compounds and other sulphur-containing derivatives are not present in substantial concentration.

A relatively simple and rapid method for quantitative determination of each of the four above-named components in gas or condensate streams has been evolved and is set forth. The two acidic substances are batch-absorbed into aqueous sodium hydroxide solution while the two thio-ethers are simultaneously taken up in benzene. The liquid phases are then separated. Quantitative determination of hydrogen sulphide and methyl mercaptan in the alkaline aqueous solution is carried out using potentiometric titrations with silver nitrate. Quantitative determination of methyl sulphide and disulphide in the benzene solution is carried out by conducting bromate-bromide titrations of the components after having partly separated them by a single stage batch distillation. Results obtained on known mixtures of substance are set forth.

The method has given reasonably satisfactory analyses of two gas and two condensate process streams in a kraft pulp mill.

Kraft Mill Gases

A paper written by H. W. Bialkowsky and G. G. DeHaas on "A Catalytic Oxidation Procedure for Determining Sulphur Compounds in Kraft Mill Gases," was presented by Mr. Bialkowsky. The abstract of this paper is as follows:

The sources of kraft mill odors and atmospheric sulphur losses are reviewed, together with various analytical procedures for measuring sulphur compounds in the gas streams. These methods include the precipitation techniques with mercury and cadmium salts for differentiating between hydrogen sulphide, mercaptan, and dimethyl sulphide; the potentiometric silver electrode-silver nitrate titration for inorganic sulphide and methyl mercaptan; the bromine-oxidation method of Siggia and Edsberg for determining alkyl sulphides and disulphides. A rapid method is described for measuring the total sulphur and sulphur dioxide, and the difference is considered to be the sulphide type sulphur consisting of hydrogen sulphide, alkyl mercaptan, and sulphides. The method is based on the catalytic oxidation of the sulphur compounds in a quartz combustion tube at 1000°C. to sulphur dioxide, the sulphur dioxide in turn is oxidized to sulphuric acid in a hydrogen peroxide absorption solution, and the acid is determined by changes in pH. Individual tests can be made in less than a minute and the procedure can be used for continuously recording the sulphur content of gas streams. The method is capable of detecting a fraction of a part per million, and by proper dilution, gas streams containing several hundred thousand pounds per hour can be measured. A definite volume of gas can be tested in the analyzer, or tests can be made continuously. Sulphur dioxide in the original gas sample is determined by by-passing the combustion tube. Tests are described on various known concentrations of hydrogen sulphide, dimethyl sulphide, carbon disulphide, sulphur dioxide, and mixtures containing methyl mercaptan. The method has been applied to most of the gas streams found in kraft pulping operations including stack gases, lime kiln gases, digester relief and blow gases, evaporator vents, and building ventilation.

Chips from Sawmill Refuse Wood

V. L. Mauerman, Weyerhaeuser Timber Co., read a paper on "The Production of Chips from Sawmill Refuse Wood from a Kraft Pulp Mill."

In his paper Mr. Mauerman said "the sources of wood are as follows—"(1) Second growth thinnings consisting of the small second growth trees that have been selected by the foresters to be removed from heavy stands of second growth. This allows better growth of the remaining timber, as well as recovery of raw material which would be lost due to natural thinning. (2) Relogging of timber that has been left on the ground after the main timber has been removed. This wood can be picked up with lighter equipment that is less expensive. (3) Wood logs and other logs not suitable for lumber as broken logs, shaky logs, and logs containing some rot and stain but having sound fiber. (4) Veneer chips from

the reject veneer. (5) Waste wood from the sawmills, consisting of slabs, edgings, rejects from the trimmers, and other material not suitable for the manufacture of lumber."

Mr. Mauerman said that "In the past an average of 0.188 unit of chips per thousand feet of lumber was reclaimed as chips, but since the installation of the hydraulic barker we are averaging 0.580 unit of chips per thousand feet of lumber. One man is now removing the undesirable material from the conveyor where it took four to five men to pick an equivalent amount of clean wood previously.

"This change of wood picking procedure has also raised some new problems in the wood room. The large pieces of timber ends must be split, and the slabs should be broken down in the sawmill edger so they will go into the chipper spout, and the large burls and knots must be picked out and discarded. The very thin edgings and shims should be picked out as the chipper knife catches them and pulls them through the chipper in large pieces. The short blocks from the trimmers will roll down the chipper spout and go in cross grain, producing long sticks. This can be taken care of by removing them before chipping or passing them through the chipper and removing the oversize pieces on the chip screens.

"With this type of wood supply and conditions of operation, it is evident that chip length before screening will be more variable than would be the case if whole logs were chipped, and the uniformity of accepted chip size will to a large degree depend on the effort expended in screen classification of the unscreened chips."

In describing the chipping of the wood, Mr. Mauerman said: "A chipper with a spout large enough for all but the largest slabs and blocks must be used. The large size spout allows the small wood to bounce in the spout and make oversize chips. To prevent bouncing, it is necessary to keep the chipper knives and anvils sharp. It is also necessary to keep the anvils set as close to the chipper knives as possible. It has been our experience that a chipper with a side anvil will produce more uniform chips from this wood than one without a side anvil. The flow of wood from the sawmill must be maintained as uniform as possible to obtain the maximum production. This can be helped by adjusting conveyor speeds and eliminating sources of hang-ups in the sawmill conveyors."

Finally, Mr. Mauerman said: "A magnetic pulley in the system is of some help in removing the smaller pieces of iron that are under the wood, but it will not take out the non-ferrous metal nor will it remove the metal that is sandwiched between the wood or larger pieces of metals, as sprockets, wedges, long rods, etc. We have installed a short section of belt feeding the chipper, using a magnetic pulley at the head end and a Rens metal detector under the belt a few feet back from the chipper spout. Any metal either ferrous or non-ferrous crossing through the field set up by the detector will trip a relay and stop the belt. The chipper feeder must remove the metal and reset the relay before resuming operation. This combined method of metal detection has worked very well but an alert chipper feeder is still in order."

Progress in Cold Soda Pulping

K. J. Brown, Forest Products Laboratory, Madison, Wis., read a paper on "Cold Soda Pulp and Products from Several Pulpwoods."

In this paper Mr. Brown showed charts of the flow-sheets of two cold soda pulping systems. One of these systems started with a strong liquor tank and then to the rotary digesters, followed by the leach drain pits and then to the primary fiberizer and finally to the press, pulper, washer, and then to the paper mill. The other system starts with the steamed chips, then to a vertical digester, next to a blow tank, and finally the rest of the system is identical with the first one.

Mr. Brown said that the cold soda pulp could be used in groundwood paper manufacturing and also as a substitute for 10% of the groundwood and 10% of the sulphite in the usual formula for newsprint which is 80% groundwood and 20% sulphite. The use of cold soda pulp alone for newsprint would make paper which is too stiff and too transparent.

Mr. Brown also said that cold soda pulp could be used in the manufacture of white colored corrugated board by using three-quarters of this stock and one-quarter of the usual furnish. In the manufacturing of toweling it has been found that pulp made by the cold soda process could be substituted for the usual furnish.

As a conclusion of his talk Mr. Brown said that the Forest Products Laboratory was now testing other species of wood for use in this process.

Freudenberg's Address

The feature of the luncheon held in the Crystal Ballroom of the Empress Hotel on Saturday, September 27, was the address by Professor K. Freudenberg, Chemishen Institut der Universtat, Heidelberg. Prof. Freudenberg was introduced by Dr. J. McCarthy of the University of Washington, who said that Prof. Freudenberg was the outstanding authority in the field of cellulose chemistry in the entire world. Dr. McCarthy said that Prof. Freudenberg was born in Weidheim, Baden, Germany, in 1886, and was educated at the University of Bonn and later at Berlin University under the well-known Dr. Emil Fischer, where he was granted his Ph.D. in 1910. Dr. Freudenberg was at the University of Kiel in 1918, later at the University of Munich. Since 1926, Prof. Freudenberg has been a director of the Chemical Institute and of the Research Institute for Chemistry of Wood and Polysaccharides. At one time Prof. Freudenberg was visiting professor at the University of Wisconsin and is now giving a series of seminar lectures at the University of Washington. Prof. Freudenberg has a membership in the following academies: Heidelberg, Munich, Helsinki, Uppsala, Lund, and Halle.

Dr. McCarthy said that Prof. Freudenberg had published more than 300 technical papers as well as four books, including a book on "Tannin, Cellulose and Lignin."

Prof. Freudenberg showed slides to illustrate his theory of the mechanism to explain the way that lignin may be formed and laid down in the growing tree. These slides showed the cell walls of Douglas-fir both de-lignified and lignified. The slides also showed the chemical formulas of coniferin and syringin which Prof. Freudenberg believes are converted into lignin with the aid of an enzyme which is able to split coniferin into glucose and coniferyl alcohol. Prof. Freudenberg said it is not known how coniferin is produced in the wood but he did show how this is diffused in the cell walls. He described the methods by which radioactive coniferin is injected into a growing tree and, according to his theory, coniferin is used by the tree and converted into lignin.

Deculator Operation

At the Technical Session held in the Lower Lounge in the Empress Hotel, with A. C. McCorry, St. Regis Paper Co., acting as moderator, C. Clark, Rotareaed Co., explained the design and operation of the Deculator, used to remove the air from the paper stock before it enters the headbox.

Mr. Clark said that the complete removal of all measurable air from the paper stock is effected by the Deculator, which combines the use of high vacuum in conjunction with rapid acceleration of the finely divided stock and impinging at high velocity against a hard surface.

Mr. Clark displayed a diagrammatic drawing showing how the Deculator is used in connection with the paper process. In this connection, Mr. Clark said, "The stock is taken from the discharge of the primary fan pump just prior to the headbox, or in the case of a newsprint machine, immediately after screening and introduced into a large receiver in which is maintained an extremely high vacuum very close to the saturation pressure corresponding to the temperature of the stock being handled. The deaerated stock is pumped out

W. W. Clarke, Longview Fibre Co.; A. C. McCorry, St. Regis Paper Co.; R. B. Morden, Morden Machines Co.; L. C. Walton, Simpson Logging Co.; and G. Ostenson, Crown Zellerbach Corp.

of the receiver by a fan pump in the basement directly into the headbox.

"The Deculator process involves the use of new techniques in stock pumping and control equipment, as well as the introduction of much higher vacuums than heretofore associated with paper machine operation. These techniques have been successfully incorporated in the Deculator design, to make the operation almost fully automatic, without attention from the papermaker. The installation of the Deculator does not affect customary papermaking practice or headbox design. The papermaker uses only one valve to control the stock flow to the headbox.

"The vacuums involved range from 26 to 29 in. mercury, depending on stock temperatures. Vacuum producing equipment is composed of one or more stages combining the use of a steam ejector and condenser where necessary, with one- or two-stage vacuum pumps. This equipment requires no operating control as it operates continuously at fixed valve settings and pump speeds. Power requirements are low compared to other vacuum application on the machine as the actual CFM of dry air handled is comparably small. Steam consumption for ejector, where required is likewise quite low. For example, a typical newsprint machine with flow rate of 10,000 g.p.m. would require about 30 b.hp. for vacuum pumps, and about 1000 lb. per hr. of 100 p.s.i.g. steam.

"Continuous recording instruments provide the operator with constant check on vacuum, temperature, and stock levels, which instruments are mounted on a panel together with push button stations for vacuum and stock pump motors."

Mr. Clark said that thirteen Deculators are now in operation. Six of these Deculators are used in the manufacture of newsprint, three in the production of 9-point semichemical paperboard, one on milk bottle and butter carton stock, one on high grade paper, and one on kraft bag specialties. Ten more Deculators are now on order, to be used in the manufacture of high quality papers, newsprint, kraft liners.

Mr. Clark said that in connection with the new high density screens which are now being introduced into the industry, high density stock will be diluted in the Deculator to the consistency required for the paper machine. The advantage of using the Deculator in connection with the high density screens will be that less power and less space will be required and the spraying and impinging in the Deculator will mix the stock effectively.

Mr. Clark enumerated some of the outstanding advantages which have been obtained by the use of the Deculator in the manufacture of various grades of paper including newsprint, semichemical paperboard, and kraft paper. In the manufacture of newsprint, the Deculator resulted in better machine efficiencies and improved uniformity and formation. In the paperboards made from semichemical pulps improved formation and easier drying of more paper with the same steam pressures have resulted when the Deculator was used. The use of the Deculator in one large Southern kraft mill resulted in a saving of approximately 1000 pounds of steam per ton of paper.

Better formation was obtained which resulted in better tests. A reduction of lump breaks and lost time resulted in an increase of 8 to 9 tons a day at the same machine speed.

Mr. Clark stated that equipment now in the process of design and manufacture incorporates simplified and more efficient features resulting in a reduction in size of the Deculator equipment.

Use of By-products

J. B. Martin, Crown Zellerbach Corp., discussed the "Utilization of Ammonia-Base Sulphite Liquor."

In this paper Mr. Martin said: "The by-product chemicals of the sulphite pulping process are discharged from the digester in an approximate 10% concentration in water. The difficult and costly removal of the large quantity of water present has long been a barrier to their profitable use. Two methods, evaporation of the water and precipitation of the solids, have been studied by many workers.

"During the evaporation of calcium-base liquor, the channels of heat exchangers tend to fill up with calcium scale. An ammonia-base cooking process has been studied to avoid this difficulty. The sulphite pulping operation at the Lebanon, Oregon, mill of the Crown Zellerbach Corporation has been carried out for several years, using an ammonia base. In addition, a sizable pilot plant has been put into operation at this mill for the evaporation and burning of the liquor. The availability of the 50% solids solution produced by the evaporator has enabled us to proceed with the marketing of the ammonia base chemicals and derivatives. We have given the trade name, ORZAN to this general class of chemicals, either in liquid or solid form.

"Ammonia-base sulphite liquor differs chemically from calcium base mainly as to its cation constituents, and physically only as to its darker color. It consists essentially of ammonium lignin sulphonates, 50–60%, and sugars, 25–30%. Its nitrogen content is approximately 3.5%. It may be utilized industrially in some of the established applications of calcium liquors."

Mr. Martin said, "that sulphite liquor by-products have established markets in the following fields":

1. Use as dispersants. The gypsum industry uses sizable quantities to lower viscosity or to increase the solids in gypsum slurries in the manufacture of wallboard. Asphalt emulsions for blacktop roads are prepared with lignin dispersants. Lignin dispersants are used to facilitate the grinding of raw materials in the production of Portland cement. Wettable sulphur powder and pest control sprays are made with lignin dispersants. They are also used as leveling agents in wool dyeing and paper coloring. It is possible that lignin dispersants may be used as additives to soaps in industrial cleaners, and in oil well drilling lignin dispersants are used in drilling muds.
2. Use as adhesives. Sulphite liquor by-products are utilized as binders in the formation of coal, carbon, and ore briquettes, foundry sand cores, and refractory ceramic bodies; also as glues for spiral paper tubing and as adhesives of remoistening tapes. More use is being found as a dust palliative for unpaved roads and playgrounds. Sizable quantities of sulphite liquor go into linoleum paste.
3. Incorporated with synthetic resins in plywood glues and hardboard binders along with phenolic resins.
4. Reaction of sulphite liquor and aldehydes under acidic conditions forms a resinous composition suitable for use as a plywood glue.
5. The sugars in sulphite liquor may be fermented by yeast to produce animal feeds or alcohol.
6. Used as partial substitutes for natural tannins in the tanning of certain leathers.
7. Synthetic gravel has been produced by the Chrome-Lignin process for the solidification of soil.
8. The presence of 3.5% nitrogen in the form of ammonia

ions makes it possible to add Orzan to the soil to raise the level of stable soil organic matter.

9. Used as a dispersant for carbon black or asphalt, Orzan is added in alkaline solution to fatty or resinous soaps. By this means quick-set asphalt emulsions may be converted into the penetrating type with slow set.

10. Because of the presence of ammonia ions in sulphite liquor preliminary growing tests have shown that the 2% nitrogen is available for direct plant stimulation.

11. By the heat treatment of sulphite liquor by-product insoluble but swellable powders can be made for use in plugging porous strata during oil well drilling.

Finally, Mr. Martin said:

"The Industrial Products Division of Crown Zellerbach Corporation is making ammonia base solids and derivatives available commercially in four forms: 1 Orzan A, a powdered solid, 6% water, with acid reaction. 2. Orzan L 45, a 45% solids solution, slightly acid. 3. Orzan S, a powdered sodium base solid, 6% water, slightly alkaline. 4. Orzan SL 45, a 45% sodium base solids solution, slightly alkaline.

"Orzan L 45 is a partially neutralized product of the evaporation of the ammonia base sulphite liquor at Lebanon, Oregon. Orzan A is produced by spraydrying the acidic concentrate.

"It is our major purpose to develop new combinations and modifications which will open new markets for our wood residues. It appears that many of these will be dependent on the presence of the ammonium ion."

Round Table Discussion

A. C. McCorry was the moderator at a round-table discussion in which the following panel answered questions concerning the variety of pulp and paper making products:

Einar Walloe, MacMillan Bloedel.
Jack Savage, Crown Zellerbach Corp.
W. W. Clarke, Longview Fiber Co.
Charles E. Ackley, Crown Zellerbach Corp.
Max Bailey, Westminster Paper Co.
S. E. Hazelquist, Weyerhaeuser Timber Co.

The questions at this round-table discussion included the discussion of rubber-covered suction rolls; the pulp cooking processes, including the side relief of digesters; the use of Western woods in comparison to Eastern woods in the manufacture of fruit tissues; the problem of lime kilns, including the problem of preventing spraying in the neighborhood of the mills by the use of improved scrubbers and other methods; many problems arising from the use of purchased chips which have varying quantities of dirt; and the best method of removing this dirt and small metal particles.

Reception, Banquet, and Dance

On Saturday evening the International Meeting of the Pulp and Paper Industry ended with a reception honoring the officers of the three participating organizations.

H. A. "Gob" Des Marais, Pennsylvania Salt Mfg. Co., acted as Master of Ceremonies at the banquet which was held in the Crystal Ballroom of the Empress Hotel. Mr. Des Marais introduced President Geohegan, who brought greetings from National TAPPI. Charles Ackley, former president of the American Pulp and Paper Mills Superintendents Assn., brought greetings from the national office of this association, and Doug Jones greeted the guests on behalf of the Technical Section of the Canadian Pulp and Paper Assn. and congratulated the officers of the three associations on the excellent program. Mr. Jones said that it was planned to have the national summer meeting of this organization in Victoria in June, 1955.

JOHN CORNELLS CO.—Publisher,
Paper Mill News

Ohio

One hundred and forty-nine members and guests attended the Oct. 14, 1952, meeting at the Manchester Hotel in Middletown, Ohio.

J. A. Van Den Akker of The Institute of Paper Chemistry, Appleton, Wis., gave an excellent talk on a very difficult subject, "Measurement of Color."

The speaker began his discussion with the questions, "What is color measurement?" and "With what does a color measuring device compete?" The intangibility of color (with respect to measurement) was dispelled with a brief review of how, over the years, men have developed means for quantitatively expressing light stimulus through the use of additive primaries. The quality of light entering the eye (on viewing paper) depends upon the nature of the illuminating light and upon the way in which the paper spectrally modifies the light on reflection. This was shown graphically to involve the product of the curves representing the relative spectral energy distribution of the illuminant and the spectral reflectance of the paper under observation. The *color* perceived by the observer on viewing the light stimulus depends in a complicated manner on personal factors, immediate past history, and the quality of the light stimulus from the objects surrounding the paper specimen. But the important characteristic of the *paper specimen* which enters into one's judgment of the "color" of the paper is the spectral reflectance curve (i.e., the "color curve" determined instrumentally with a geometry of illuminating and "viewing" similar to that of the actual viewing by the observer).

The method for obtaining the C.I.E. tristimulus values and trichromatic coefficients and the advantages of using a "standard observer" were reviewed. This discussion included a description of the chromaticity diagram which, with the luminosity axis, forms the color solid. It was also shown how numerical expression could be given to hue, saturation, and luminosity through use of the quantities, dominant wavelength, excitation purity, and luminous reflectance.

A color measuring instrument must be at least as meaningfully sensitive as the color vision of an experienced color matcher. The nature of the conditions prevailing in the matching of the color of paper is such that color matching can be done with considerably greater sensitivity for paper than for nearly all other materials. This is primarily because of the last three of the following five conditions: (1) A good level of illumination is possible. (2) Both eyes are employed in the viewing (binocular vision results in much greater sensitivity than monocular, the latter having been commonly employed in the old visual colorimeters). (3) In the color matching of paper, the two fields under observation are separated by a very fine line (fineness of the line of separation of two fields has an important direct bearing on the ability of an observer to distinguish closely similar colors). (4) The viewed area is usually large (another factor making for good discrimination). (5) Most papers have flat, textureless surfaces. One must face the fact that the trained, normal eye is very sensitive and hard to beat. Typical sensitivities were expressed numerically for different portions of the C.I.E. chromaticity diagram to illustrate the order of magnitude of the accuracies needed by spectrophotometers, reflectometers, and colorimeters for reliable measurement of color and color difference. It was shown that the accuracy required in color curves depends upon whether the curves are "parallel" (in the sense that the one curve is a factor multiplied into the other curve) or nonparallel. In the latter case, where the average difference between the curves may appear to be small, one may paradoxically be confronted with the most stringent demand for high instrumental accuracy. In these two illustrative cases the differences between the colors may be described as, respectively, only a difference in luminosity (corresponding to "parallel" curves) and a difference in chromaticity and luminosity (corresponding to nonparallel curves). Since the normal eye is much more sensitive to changes in chromaticity than to changes in luminosity, the latter type of difference is more readily detected.

For the purposes of the discussion, color measuring instruments were classified as (1) spectrophotometers and abridged spectrophotometers, and (2) three-filter colorimeters. The several sources of error of instruments of the first category were briefly discussed. This was also done for three-filter colorimeters, after stating the requirements of the spectral re-

J. A. Van den Akker, The Institute of Paper Chemistry; and C. E. Brandon and K. P. Geohegan, Howard Paper Mills, Inc.

sponse of such instruments for each filter. Instruments in the second category are not of general value in the laboratory, but are claimed to be useful in the rapid determination of tristimulus values and, therefore, of value in the control of industrial products. Two of the claims usually made for such instruments, viz., that (1) they are more sensitive than the eye, and (2) they will reliably measure color differences when the differences are small, were criticized. Speaking from experience in the testing of such claims, it was pointed out that the first claim is often invalidated by failure of the second claim; color matches in the paper industry are often metameric and, in consequence, three-filter instruments will often yield incorrect data on the direction and magnitude of differences on the C.I.E. chromaticity diagram. At best a three-filter instrument is "color blind," and the spectral responses of existing instruments corresponding to the three filters deviate sufficiently from the proper values to result in false data on color matching. For example, a really good match (to the eye) may be erroneously pronounced by a colorimeter as an unsatisfactory match; or, equally dangerous an instrumental match may be unsatisfactory to the average normal eye. Literature references covering this discussion were presented.

In discussing the question, "What kind of color instruments do we really want?" the speaker said that spectrophotometers (or suitable abridged spectrophotometers) are required in research and development laboratories; however, there is a real need for reliable, yet relatively inexpensive, colorimeters (probably *four*-filter instruments) for the control of color in the mills.

G. B. Gregg, *Recording Secretary*

Lake Erie

The Lake Erie Section held its October meeting at the Hotel Carter. The subject for the evening was "What Printing Process for What Job." Richard F. Koppe, Art Director of Packaging, Procter & Gamble, Cincinnati, covered the subject from the artist's point of view and discussed the value of one type of process in comparison to the other. Mr. Koppe discussed color association and how different colors are associated with different materials. He pointed out how this had to be kept in mind while at the same time various colors are worked in to associate the product with heavy duty or dainty purposes. As for the characteristic of the packages, it is necessary to consider the material being packaged in the carton and the trade channels that the package will follow. The value of a product and the amount that can be spent in packaging dictate whether it shall be a fancy package or one which will stand hard use. He pointed out that of the three processes, letterpress, offset, or gravure, all can be used for a given job. Good quality letterpress printing can match a lithograph job. Usually, it is economic factors of the processor which determine which process he uses. Often companies will be purchasing cartons which are printed by different processes for the same product. These cartons have to be within the commercial tolerances so that they can be displayed side by side. In some instances, it is difficult or impossible to distinguish one type of printing from the other.

Charles F. King, Technical Director, U. S. Printing & Lithograph Co., covered the subject from the technical side. He discussed various aspects of the letterpress, offset, and gravure processes. Following the talks, an interesting discussion period was held.

What Printing Process for What Job

Charles F. King

If it were possible to do, I would like to be able to put a chart up before you and say, "All you have to do is refer to the chart and you can tell which is the best way to print any job." Unfortunately, or perhaps it should be fortunately, it is not possible to make such a chart, and even if it were possible, I am afraid it would become obsolete before it could be widely distributed. A good example of this may be seen in the progress made in the printing of "daylight fluorescent" inks. Only a short time ago it was a generally accepted fact that the only method which could be used in printing these inks was by silk screen, but before long, successful attempts were made to dust these pigments on letterpress sized and even lithographic sized prints in a bronzer. The pigments were further improved and gravure fluorescent inks were made available. During the past month I was handed some very excellent samples of single impressions of letterpress fluorescent printing which were run on a commercial job. As yet, I was informed, it is not ready for use on lithographic presses.

Perhaps the printing of daylight fluorescent inks could be classed as a novelty and might not be thought of as having much influence on the printing industry in general, but it does illustrate the rapidity in which changes take place. Today a particular job cannot be printed by one or another of the processes, and tomorrow someone is doing it by that process. Up to this minute, as far as I know, a few rather positive statements can be made. (The picture may have changed since I left home. If so, forgive me.) The best methods for printing special materials such as metal foils and plastic films are gravure and aniline where highly volatile inks can be employed. Silk screen can be, and has been used for the same reason. Thus it is the type of ink rather than the method of applying it which in some instances

Charles F. King, Technical Director, U. S. Printing and Lithograph Co.

determines which method can or should be used. This is also true in some instances in printing on paper or board. For example, gravure can print a beautiful impression of gold ink, which carries with it a certain degree of protection against tarnishing and rubbing. Letterpress, too, will lay a beautiful film of gold ink, but it usually will scuff easily and tarnish rapidly. Also it is usually necessary to run even a rotary press a little slower when printing gold ink than when standard colors are being run. As for offset lithography, it cannot run gold ink.

Many attempts have been made to make such an ink for lithography, but as yet two factors have thus far made it impossible. (I say thus far, because by the time I get back to my desk, there may be announcements that gold ink for offset is now available.) These two factors are: (1) the density and size of the particles of gold bronze, which prevent their transferring through the inking system to the plate and from the plate to the blanket and thence to the paper. Perhaps if a heavy enough vehicle could be used to carry the bronze and still permit leafing, this difficulty could be overcome. (2) The chemical nature of the process presents perhaps a greater problem. Of course, as you well know, the bronze powder used in gold ink is brass, and the acids found in the water fountain system cause the brass to tarnish. Also, each particle of gold is covered with a film of grease, which causes the plate to take ink in the portions on which it is not supposed to do. Incidentally, it is this problem of particle size which has also kept the fluorescent inks out of the offset field up to this time.

There are also other peculiarities of either materials or the process itself which make necessary the use of one particular process or the other. For example, it is possible to spot lacquer on a gravure press whereas it is not possible in normal offset and letterpress operation. Likewise, it is possible to make changes in parts of a form at any point during a letterpress run, but such changes may be impossible in either gravure or lithography. Perforating, scoring, or numbering are printing operations which may positively limit a job to letterpress.

Thus far I have limited this discussion to more or less special operations and have pointed out that these may be the determining reasons for a job being printed by one method or another. Eliminating the specialties for which one process may be better suited than another, there is only one other factor to be considered in determining by which method a job should be printed, and that is *cost.* On this subject very few general statements can be made. Perhaps the most general can be made concerning gravure. I believe that it is generally recognized to be the cheapest method of all, but the high cost of preparing cylinders for a job necessitates a run long enough to absorb this cost. The presses are most simple, and make-ready practically nonexistent. In the case of printing publications where sheet size is always the same, standard size cylinders further help in holding down costs. When you consider that the latest figures published in the trade journals indicate that according to the sales of equipment the gravure industry is expanding more rapidly than either letterpress or lithography (and in the order named, believe it or not) it indicates that more and more work is going gravure. This appears to be long-run work in all classifications.

The comparisons between offset lithography and letterpress printing are not as easily made. Often in the particular plant in which I am located the deciding factor is pressroom activity, or how soon the job must be delivered. Time and again the costs are almost identical. This, however, is not true with all types of work or all types of equipment. Actually, there are four factors which most greatly affect the cost and account for the differences between printing either by offset or letterpress. These are: the cost of the printing form, make-ready cost, comparative speed of presses, and the paper. What I mean by the cost of the form is rather difficult to describe when all of the different classes of printing are taken into consideration. An example from the label or carton business would illustrate one class of job. Where a number of the same items are up on the same sheet, the cost of the electros necessary to fill the sheet can be far in excess of the cost of the lithographic plates required. However, there are conditions under which this is not true, or due to the length of the run, the cost only shows as a very small percentage of the unit cost of the job.

At the other extreme, there are many jobs which are mostly composed of type matter, and with this locked up on a flat bed press, the job can be run off before an offset plate can be made. Between these two extremes there are all manner of jobs, each one of which must be calculated individually. Generally speaking the number of illustrations found in the form determines to a large extent which method is cheaper.

Closely tied in with the cost of the form, is the cost of make-ready. Some people are under the impression that there is no make-ready involved in offset lithography. *This is not true.* Strictly speaking there is no make-ready in the sense that a letterpress plate must be built up in the solid areas, and dropped back in the highlights, in order to make it print correctly. However, if this was all that there is to letterpress make-ready, plates with pre-make-ready built into them would completely eliminate letterpress make-ready. However, most of us know that this is not the case and much more is involved in getting a job running. Offset make-ready is fast. It may run from a matter of minutes to a few hours, depending on the size of the press, number of colors, and a number of other factors. Only when the cost of make-ready can be absorbed in the length of the run, can letterpress compete with offset in this department. Nevertheless, the cost is higher than gravure.

The comparative speed of pressures is another factor which governs by which process a job should be printed. If web-fed rotary letterpress is compared against offset and gravure, offset lithography runs a poor third, and only the cost of the form and the make-ready time are in its favor. With sheet-fed rotary equipment the differences in speed are not very great, but when offset is compared against flat-bed letterpress, one wonders why there are any flat-bed presses left in the country.

This brings me to the fourth factor which determines how a job should be run, and this is the one in which you are the most interested. Most of my experience in the gravure industry had to do with the making of gravure inks. In fact a goodly portion of my experience in the graphic arts industry has been connected with the ink end of the business, and oh, how I have longed to be a paper chemist. It is always up to the ink chemist to find the means to cover up the paper chemist's brainstorms and mistakes. From what I have seen, the ink chemist has found means of printing by gravure on just about anything which can be rolled up and fed through a gravure press, but between letterpress and offset, some peculiar conditions exist.

As far as the actual cost of the stock is concerned, sheet for sheet, there is little difference between the same grades of stock for each process. If there is any edge it favors the letterpress printer, especially in the case of board stock, and some grades of coated paper. But, you may say, "Offset always has the edge since it can print on rough papers." That is true, but this ability has hurt lithography just as much as it has helped it. This is especially true in black and white printing where the snap found in a letterpress print on coated paper is frequently compared against an offset print on offset stock. Due to the optical properties of the surface of the sheet it is impossible to produce the snap or density range possible on a coated sheet. The letterpress printer drops to a coarser screen and sacrifices detail to maintain this snap when called upon to print on rough stock. The offset printer sticks to 133 line screen or finer and then wonders why his prints are flat, gray, or washed out. There are also such

factors as bleeds, catch room, running images head-to-head which affect layout and permit a smaller sheet to be run cheaper by one process than by another as far as the cost of the paper is concerned. Therefore, it is impossible to say that either process has much of an edge over the other when comparing paper cost.

Up to this point I have made no attempt to compare the quality of the printing produced by each process. Rather than become embroiled in any argument at some later date, I might just dismiss the question with the simple statement that each process *can* turn out jobs of equal quality. I should then say if, and a great big portion of that "if" has to do with paper. If, for example, it were possible for a board mill to hold its caliper within less than 0.001 variation and its surface as smooth as it is when the felts on the machine have just been renewed, it would be possible to print halftones or vignettes on bleached manila board equally well by either process. As it is, offset vignettes are much better and much more uniform. A mere matter of a thousandth or so has little effect on the print from a rubber blanket, but in letterpress you are either punching the sheet or breaking up the print with that much variation.

Just the opposite can be said for another property of stock. Although the ability of the surface of a sheet to remove ink from the printing form is important in both letterpress and offset printing, slight variations are less likely to present the problem of color variation in relief printing than they do in offset lithography. The mechanics of ink transfer in printing from a metal form is entirely different from that involved in printing from a rubber blanket. Also a much larger volume of ink must be carried in order to make up both for the irregularities in the surface of the paper and in the metal printing element itself when letterpress is employed. In offset where only limited pressure is employed and only a thin volume of ink carried, slight variations in the surface can account for great variations in shade. In fact when the same stock is run on a letterpress press these variations in shade do not show up.

There has been much printed concerning the need for dimensional stability of stocks to be used in lithography, and the reasons why curling tendencies are so much more important in this phase of the industry, but little has been said concerning other properties such as those mentioned above. Paper problems are constant headaches to users of all three processes, but many of these problems never get back to the mill either because the printers for the most part do not have the technical staff to actually determine that paper is the basis of the problem, or through the skill of the technical man in the ink laboratory the problem was solved, at least for the time being.

It is a peculiar situation that exists in the relationship between the printer and the mill. Even when stock is purchased directly from the mill, the printer has little or no contact with the technical staff. Instead the mill sends its sales trainees to spend time in printing plants and the printer in turn sends his sales trainees to the mill, but seldom do the production and technical men from both organizations have the opportunities to study the problems first hand.

The December meeting of the Lake Erie Section was held on December 12. This meeting was a Christmas party in which the wives were invited and was held at the Hotel Carter.

L. E. Rolig, *Secretary*

Chicago

At its October 22 meeting fifty members of the Chicago Section heard A. Newell Rumpf, Vice-President of the Harris Trust and Savings Bank, Chicago, discuss some of the economic aspects of the paperboard, paper, and pulp industry.

Mr. Rumpf recalled that in a similar talk before the same group about a year ago, a note of pessimism was given. This

A. Newell Rumpf addressing Chicago TAPPI

was because the relation of production to basic demand indicated that output was ahead of actual usage. Orders received were less than productive capacity. On a short-term basis, while it appeared that over-all production was on a pretty firm level, nevertheless, over a longer term it was felt that a period of digestion was in order. Now, however, on Oct. 20, 1952, the latest figures indicate that total production is 88.6% of rated capacity. This compares with 99.5% for the corresponding week of 1951. For paperboard the most recent figure stands at 94.0% compared with 90.0% in the same week last year.

The reasons for the low activity of the past year are largely known, explained Mr. Rumpf. At the beginning of Korea, a rush of buying of a hoarding nature was instituted. When it became apparent that paper was not in short supply, and when inventories generally were pyramided at the manufacturing and distributing level, a wave of cancellations and retrenchment took place. The first to feel the change were the paperboard producers. Next to feel the reduction in demand were the tissue mills, indicating that in spite of high national income, the pipe lines all along the line were filled.

Now it appears that recent excess inventories in the hands of users have been liquidated and that a renewal of the basic strong demand for board and paper products will result. After a slow first half, he expects total board and paper production in 1952 to be somewhat between 24.5–25.0 million tons which would compare with 26 million in 1951 and 24.4 million in 1950.

The recent decline in Canadian and Scandinavian pulp prices was to be expected. However, the truth of the matter is that these prices were on the high side a year ago as a reflection of the abnormally strong pulp demand. For example, Scandinavian bleached sulphite pulp was at $250–$300 a ton in early 1951 and Canadian pulp was $155–$160 a ton as compared to $145 for domestic pulp. Now both of these pulps have come down to meet the more realistic (and consistent) domestic price.

Mr. Rumpf indicated that there are three factors which give concern to the banker when viewing the industry's future, namely taxes, cost of replacement of machinery, and expansion.

The impact of Federal income taxes on the industry acquired terrific force in 1951. At their peak during World War II, they amounted to 9.1% of sales, 11.6% of net worth, and 8.3% of total assets. In 1951 they were 13.1% of sales, 21.6% of net worth, and 14.4% of total assets. When income taxes and profit taxes take over 21% of net worth against 5.9% for dividends and when these taxes take more dollars out of the industry than was paid in wages, it would appear that the industry is being bled white and it is time to check government expenditures.

With high cost of new equipment to increase productivity, normal depreciation standards are insufficient and must be met out of new capital. This high cost restricts new entrants to the field. Planned new capacity through 1955 is 2,304,000 tons over December, 1951. Of this—1,033,000 tons is paper and the balance, board. This represents a 12 and 15% increase, respectively, over 1950 to a total of 27,750,000 tons. Some of this may be canceled or delayed, Mr. Rumpf stated, but one is prone to wonder if it can all be put to profitable use.

REPORTS AND DISCUSSIONS

Papermaking (Cylinder)

The meeting convened at 9:30 a.m. Wednesday morning, Feb. 20, 1952, James J. Harrison, Michigan Carton Co., of Battle Creek, Mich., presiding.

CHAIRMAN: I think we might as well get started.

It was not my intention to run this meeting. Glenn Renninger, of Container Corp., was supposed to show up this morning, but I had a phone call from Philadelphia last night, which I did not receive, and I think he probably called to tell me he could not be here today.

I think first of all we should explain what it is we are trying to do, but before that we have a few apologies to make. We did not get our announcement in *Tappi* early enough. It was supposed to have been put in the November issue, and it was not put in due to my neglect, and so some of you have questionnaires and some of you do not.

What we had in mind for this particular meeting was to try to get the people who were engaged in making paper into a meeting in order to have some discussion of their common problems, and then to break this committee down, if possible, into working committees.

Those who are interested in stock preparation will meet tomorrow. Joe Loomer is going to conduct the meeting as a round-table discussion.

There is one thing we are not basically sure of here, namely, how much approval or disapproval there is in this group for excluding the suppliers from these meetings. I have had comments both ways. Most comments have come from one or two suppliers who said they thought they should be here. Others said the mill men only should get together about once a year and discuss their problems. "They can cuss us up one side and down the other, and we'll find out what they don't like anyhow." They thought it was a good thing they had been excluded.

After the meeting is over I'd be glad to have you tell us, if you don't care to say now, whether you think it is a good idea to have this type of meeting or not. We are in a small room this year. The reason for that is that last year we met in the East or West Ballroom. Unfortunately, it seemed there that you were looking away out in space, and nobody would say a word. Aside from the papers presented, I don't think there was any discussion at all, and that does not make for a successful meeting.

We thought we should discuss the general subject of problems in operating and pressing on cylinder machines, which is a good subject as I think all of you will agree. We sent out questionnaires, the prime purpose being for the benefit of some of you who may not get out in the machine room too often, to help you to get reacquainted with the problems so you could discuss them at this meeting.

I don't know what problems you would like to take up first on the wet-end operation, but as far as I am concerned, one of the phases we find most difficult is in the approach flow system—how to level it out.

Granted there are 50,000 varieties and ways of doing it, I would like to have somebody start telling us what you would like to talk about this morning. This is going to be a meeting purely for discussion purposes. There are no papers, and I am not going to stand up and talk to you all morning, that's for sure.

MEMBER: I am interested in discussing vat temperatures. We run our cylinder machines from 110 up to 130° at times. We don't know whether the change in viscosity from 110 to 130° actually helps drainage, and we do not know whether it hurts our formation.

We have observed some results of increased drainage on heavy weight board such as 65-point mounting board. We recently raised the temperatures up slightly over 130 and increased our speed 10 or 15 f.p.m., over what we normally could make. I am interested in finding out what vat temperatures others are using.

MEMBER: Do you run new top-grade premium boards at all?

MEMBER: Machine-coated boards.

MEMBER: I should have qualified that. On our liners, on white liner boards, we keep the temperatures down, depending on the sizing in them, to 110 or 115°, so when it reaches the machine, it is below 100° in the liner vats. I am speaking primarily about the fillers.

MEMBER: The filler is, of course, a different picture. As far as the top liner vats are concerned, and regardless of sizing, you generally sacrifice formation as you increase the temperature.

On that basis I know that one rule of thumb is this, if you are running chip boards, for example, then you run the vats as hot as you can in order to get increased drainage. You cannot do that for top-grade boards, because you start to sacrifice formation, unless you have other means of accomplishing it.

MEMBER: We have tried running our vats at various temperatures. On our top liners we have tried from 70° up to about 110°. Because of the problem of stock preparation, we have dropped our top liners on white boards and higher grades back to around 85°.

MEMBER: How about your filler?

MEMBER: On our filler we carry about 110° in the vats. Our filler grades run pretty heavily to news. It does not seem to affect the formation one way or another on short-fibered stock. Actually, I think that if we had more steam, we would use it. But that seems to be where our steam consumption equals the boiler output.

MEMBER: We went to hot water on our machines on the basis that we would get better drainage through the felt if we weren't bothered about the drainage through the cylinder. We obtained more efficient operation through the felt and press section.

We have gone up as high as 150° on tube sheets made from corrugated boxes. With the temperature that high, we found we were having a hard time keeping the filler up. We had difficulty hydrating the fibers and beating the fibers at that high temperature. We had to drop our temperature back down.

MEMBER: We are running our fillers 110 to 120°, with the liners probably around 100. We find we are getting much better drainage on fillers.

We used to run a low temperature in the Winter months. We are getting better drainage on fillers by getting our temperatures up to 110 and 115°. I am not sure about liners. We probably run too hot sometimes, and probably get into trouble because of it.

MEMBER: Do you find it makes any difference on forming your sheet when you get the stock too hot?

MEMBER: Yes.

MEMBER: The reason I asked is because it seems to me I have heard the newsprint operators say that there is difficulty on a newsprint sheet when it is pretty hot.

MEMBER: We have a lot of fines in there.

MEMBER: Would that be similar to what we use in the filler?

MEMBER: May I ask the first gentleman a question? You mentioned the fact that your high temperature was confined to your filler. If you are running a top-grade board, would you run a hot filler on a cold top liner?

MEMBER: Yes.

MEMBER: Have you run into any trouble on that?

MEMBER: No.

MEMBER: When you are doing that, your running freenesses in the vats are going to change. In other words, you are increasing the running freeness of your filler stock and your top liner is colder. You may possibly be slowing up the stock from the running point of view and might possibly cause some problems such as separation, etc.

MEMBER: We have four suction rolls on one machine, three on the other. That suction of the Beloit rolls is pulling from the top of the sheet down through the filler and out through the bottom. Maybe that is a compensating factor.

MEMBER: That is right.

MEMBER: I wouldn't say they never had a blow. I think that when we do it, it is more a problem of not refining the stocks correctly.

MEMBER: The question of vat temperatures certainly cannot be separated from freeness, because we are talking about a freeness effect. The question we have been tossing back and forth among ourselves in operating at various temperatures is whether or not there is any effect other than the effect on freeness.

Of course, when you are talking fillers, you are talking of slow stock, and slow enough so that you can get formation—it forms well—and if you increase your temperature, you increase your freeness, you increase the drainage, and you can do a better jot.

On top liner, if you are running a longer stock and try to run it hot, is it not possible that the failure to form is purely a matter of freeness, whereas if you tried to shorten that fiber or beat the fiber and tried to get it slow enough to form well, then the fibers may have some characteristics, such as poor bender, or other effects of short fiber. Consequently, we have been unable to distinguish the effect of temperature as such from freeness as such. We are absolutely unconvinced that the temperature has a thing to do with it, except as it affects running freeness.

MEMBER: You can reduce your viscosity which reduces your freeness.

MEMBER: Is it all viscosity effect?

MEMBER: I don't know.

MEMBER: It is all a drainage effect, you might say.

MEMBER: If we could be sure it was all a drainage effect and that there wasn't any of this gelatinous surface on the fiber that has been talked about a great deal in the research groups, we would be freer in our approach to it.

There has been talk about hot fibers being brash and dry as compared to a somewhat gelatinous surface and greater fiber adhesion at cold temperatures, but the research people have not agreed to that.

MEMBER: I don't know whether they could agree on that. Do you actually ruin your hydration when you heat it? If you could hydrate first and heat after, that might help.

MEMBER: That has been our experience. We cannot run top liners at high temperatures at all. In fact, we are down to 70° most of the time. On the fillers, yes. We get it up to 100 or 110°. What we lose is not from the formation standpoint. I think the mill is constituted to take care of it, and adjustments are made in stock treatment for the false freeness effect, if you like to call it that. But we definitely lose bender. We are in trouble right off the reel. The sheet starts to crack as soon as we have a high temperature in the top liner.

MEMBER: Is your effect caused by the fact that when you try to run your top liner hot, you must shorten it, and it is the shortness which causes your decreased bender, rather than the temperature.

MEMBER: I wouldn't be surprised. I think that may have something to do with it. We have never delved into that particular problem to see if that really was it. I don't think there is any doubt about it, myself. If you hold your given formation and raise your temperature, you have to do something to your stock treatment.

MEMBER: When you heat the stock, you certainly change the freeness. But I think that may be wrong. If you run the same freeness and have enough water, I think the big trouble in most cases is that you have no suction. You get a free stock, but you don't have fan pumps to carry the stock. You shorten the stock up with easier drainage.

It has no more water; that is what it comes back to. Everybody is worried about the stock. I will bet that there are not five mills where you can have free stock and run it at any speed, and still get any suction on the mold. Generally you don't do it. More and more people are coming to air suction in the cylinders.

MEMBER: Formation and freeness are two things that bother me quite a bit. When we started our new machine, we had formation trouble. It still is not perfect but is considerably better than it was 2 years ago. I have checked the freeness at various points in the system out of curiosity. The stock with the fan pump water going to the vat shows absolutely no relation to formation in our machine. We went all over the lot in freeness. We would have a certain freeness in the beater room, and you could run three or four beaters with the same freeness. By the time it was diluted with fanpumped water, the freeness could be a hundred points different. As far as the operators were concerned, they weren't changing a thing. The actual drainage characteristics were entirely different.

MEMBER: The fines enter into that, of course.

MEMBER: The fines are in there.

MEMBER: We have quite a different problem. A machine may go completely bad with stock so slow that you can't run it, but the freeness has not changed.

MEMBER: I am curious to know if you ran other tests like fiber classification or anything of that kind, along with the freeness tests.

MEMBER: We arrived practically nowhere on those; actually we could tell very little.

MEMBER: We have not been able to tie in fiber classification with function on the cylinder machine at all. That has been our experience, too.

I am somewhat of a fanatic on the subject of drained air. When diluting fibers with white water, and taking stock out of the headbox and trying to associate freeness with what we are finding, the Canadian freeness tester is so greatly affected by the amount of entrained air that is beat into the stock, that we have been almost unable to get a conclusive freeness reading because of the buoyancies of the fibers. The rate at which they settle on the screen in the Canadian tester is greatly affected. You can get an entirely different reading, depending on the air present.

MEMBER: We operate two machines making the coarser grades of paper board. I think that one thing we have to bear in mind when we talk about vat temperatures is the grades we are trying to make. We are limited beyond formation problems by sizing.

You certainly cannot afford to have a temperature much in excess of 110°F. and get sufficient sizing at your vats. In our case we do very little sizing, and for the most part, we run our vats 140 to 150° on chips, news, and bending fiber. We get away with it nicely.

We have no suction apparatus on either of the machines. We have no suction on the wet end, except flat boxes. We are able to send the sheet to the driers at a moisture content

around 42 to 44% air dry. In one case we have four primary presses and a secondary and third press.

The advantage, in our case, is more production by running higher temperatures. We are also limited in the stock preparation end. We have to run the water temperature in the beaters up to around 160°. That recircles around and around. By the time it gets to the vats, it pulls off, and that is our cycle.

As I said, we get away with it very nicely.

MEMBER: That is a good deal warmer than we have ever had.

MEMBER: You mentioned 70°. That would be in your beaters. What temperature would you have to maintain in the beaters to obtain 70° in your vats? 60°?

MEMBERS: I would say so, around that.

MEMBER: You don't have any trouble beating out whites at those temperatures?

MEMBER: Yes, we have trouble with hard whites.

MEMBER: We prepare our whites with 70° water temperature in the hydropulper. Our fillers which are primarily news, will run even on white liners as high as 140 or 150°. We don't go that high where we are looking for strength properties in the filler, but we have had very little trouble as far as the formation is concerned.

One difficulty we have run into on formation particularly is, when we are using hard whites and someone slips us a little carbonate, we lose the pH, the sizing, and the clay. The same can happen if your vats are too hot. You do not retain the filler and the size.

The other thing that I think has a bearing on this whole picture of temperature is the vat temperatures that you carry. That is, assuming your sheet averages 90° going into the drier section, it certainly is not as good from a production standpoint as 130° if you can run it that way, because all you are doing is taking three or four or five driers on your machine and preheating the sheet to the old temperature which I think has something to do with why we are all looking for hotter sheets.

MEMBER: How dry is your sheet going in?

MEMBER: It would be around 56% water, and the temperature of the sheet in the driers, in our case, is as high as 125°.

MEMBER: The question of dryness going to the drier section is part of our subject, and perhaps it is closely related to it. It would be interesting to hear how he gets that dryness in addition to the temperature. If we are getting it by extremely high pressures in the press section we are then, of course, limited somewhat as to what kind of grades we are forming. But I would be interested in hearing what the pressures there are.

MEMBER: That is a question I am not in a position at this moment to answer. I don't think anyone in our organization can answer it. When I got this questionnaire and started asking the superintendent and the other operators, they threw up their hands and said, "I don't know." We load the baby presses and the first and second presses with weights as far as we can without crushing.

MEMBER: In connection with this high temperature going to the driers, are any of the mills using pre-driers before the last press?

MEMBER: I only know of one machine.

MEMBER: I wonder if there are some mills using red ray burners between the last two presses to elevate the temperature and get more moisture out of the last press.

MEMBER: I was at a board mill last Fall where they were apparently short of drier capacity. I asked them the first question, what is your moisture going on to the driers? They did not know. They hadn't the faintest idea, and had no means of finding out, not even in the laboratory. It seems to me there is room in some board companies for a very big advance in knowing what they are doing.

MEMBER: I was going to ask how much of a study had been made. We are now at 40° in the vats. We have the first suction roll put on the cylinder machine, which is no good at all. Then, we do not use baby presses; we can't. We have one main press, then the two presses with plate felt that do not take out much water, but we have 60% moisture going into the drier. So maybe everybody is breaking their necks to accomplish something when, as a matter of fact, you cannot get more water out of the sheets. Everybody seems to be running 60% when you ask them.

MEMBER: The only thing that I have heard is that you can press down to 45. It is possible to go somewhere between 45 and 50. In our particular case, if we go in at 38, we consider it very good. We have found, on our higher speed machine, that is a little more difficult than it is on the slower speed machines. Apparently it is not the weight that is important. It has something to do with the number of presses and the time it is under a press.

MEMBER: There is just so much water that you have to evaporate. You cannot get it out any other way.

MEMBER: I am wondering why he says the suction presses are no good.

MEMBER: I would say that ours are not. We are running the first we ever put in, and that happened 45 years ago. The pressure has been running ever since.

MEMBER: I do think there has perhaps been some improvement in that length of time. Of course, we all have a little different type of stock. There are some people who run very similar grades, and some are kind of out at the sides. In our case we run from a straight groundwood-sulphite sheet down through chip. The strange thing about it is, it does not seem to make too much difference going to the machine. We get within 1 and 1½% going into the driers, regardless of what we run. So apparently there are other compensating factors such as speed that take care of it.

However, on this question of pre-driers, there are some machines on which they have been added recently. We have recently decided to put in a press in the drier section, and next year I will probably be able to give you a better answer on it than I can now.

MEMBER: On a cylinder-type drying machine, the pre-driers will take the last press section, with the assistance of two or three pre-driers wherever they can work in, and you can remove 5 or 10% more moisture with the last press section than you can without it. That is a proved fact.

MEMBER: The Canadian mills, or one of them, did not have too much success with pre-driers, not from the standpoint of water removing, which you certainly get, but from the standpoint of disturbance of the top liner. You get a lot of plucking and that sort of thing, and it gives you a sheet after the pre-driers that is radically changed from that which you are attempting to make. So a word of caution is necessary on that score. I am only passing along a thought, not talking from my own experience.

MEMBER: That is very important. You have to make sure you don't exceed the temperature or get up to the temperature of steam, or you start blowing your sheets off. Another thing that you have to be careful of is the pressing. If you do not, you start making really a sheet of board. It is quite stiff, etc.

MEMBER: That is one of the problems I have been trying to solve. We have a smoothing press in the middle of our driers which we have never been able to use. We couldn't get anywhere with it. We start getting picking as soon as we get any weight on it at all, although last Fall I was down South and found that they are using them on practically all the machines. They have the new special rubber nonsticking rolls, and that has practically cured picking.

MEMBER: I might make a few remarks on tests we made up in Canada in attempting to determine the production efficiency rate as related to drying. We received questionnaires from quite a few mills—I think it was somewhere around 18—

and found that the best results were from a mill that is using pre-driers. They go in as low as 54% to the driers.

To my mind, all they are doing is, instead of running the stock hot in the vats, they are heating it up to reduce the viscosity of the water at the third press, and they are getting the same results as those who are running the stock very hot. Then too, they are not running too fast, but they do get very good results.

In regard to Anglo-Canadian, the trouble was, I think, that they had very few driers, and they were attempting to press too hard, which hurt the sheet, of course, and made it tinny. That was the only trouble they had as far as pre-driers are concerned before the last press.

We got very peculiar results. It is hardly believable, the difference there is between mills. We found mills with the sheet going into the driers as high as 70%. When you realize that 1% difference in moisture at that point amounted to about 5% difference in production, if the driers are your bottleneck, that really means quite a lot.

MEMBER: You mentioned that you have a smoothing press that you have not been able to use yet.

MEMBER: Yes. In fact, we have two of them.

MEMBER: We have two in operation now, not for the purpose of removing water, but strictly for the purpose of smoothing the sheet due to a lack of calendering, and the problem of acquiring density on some sheets. We operate them sweating.

MEMBER: With steel rolls?

MEMBER: Steel rolls. We sweat them with cold water. We feel it gives us quite an improvement in smoothness to remove any felt marks that might be there.

MEMBER: That is a possibility as we have been considering what to do about them.

MEMBER: I don't recall exactly what the nip pressure is, but on things such as patent coated board, we will run them bare with 40 p.s.i. It is about a 16-in. steel roll.

MEMBER: That is fairly high pressure.

MEMBER: We have a smoothing roll on one of our machines. It does help the density and smoothness. It makes quite a difference.

MEMBER: Our last press before the drier is a smoothing press. We don't get sticking, but we can't load it because we get crushing. Our sheet is still too wet to take a bare press. I think if we can get the moisture down, we can load it.

MEMBER: You don't have trouble with blowing?

MEMBER: Oh, yes, blowing or crushing; it is either one or the other.

MEMBER: You get away from the blowing, by the way, and lead it into the nip. We have a smoothing press before it goes into the driers. We work the hell out of the thing. We had blowing a lot until we fed it into the nip, so the air could escape both top and bottom. It had a straight feed through. Some run it direct from the press. In our case it went around the top roll and came back through. We had blowing all the time and could not work the press. Then we put in an idler roll. We put it over the sheet, and the air escaped both top and bottom, and it was all right after that.

We are in the process of remodeling our whole wet end, so I am talking about past history, and I know nothing about what is going to happen. We have four cylinders, and we made up to 60 points on that. All you have to do is go slowly enough, and you can make anything. We run 32-point boards through the smoothing press, though.

MEMBER: One other thing I have found. If you run the heavy caliper sheet, if you put too much pressure on the smoothing roll, you run into a blow. Not the light weights, but heavy weights.

MEMBER: Has anyone mentioned the effect of the different kinds of felts on water, either water removal or formation? It seems to me a terrific amount of change can come from that. I used to be in textiles. One kind of textile differs as much from another kind as one kind of paper differs from another. It seems to me that felts are very, very vital to your whole problem.

MEMBER: Keeping them clean is important. If you get a press plate on and don't keep it clean, you are going to have trouble. I would be interested in knowing whether people are cleaning their press felts at that point. There is a tendency, I think, for a lot of people to eliminate press felts. Some people have done so. It would be interesting to know what the experience has been. There has been a tendency to skip the second or third presses, or to eliminate them altogether.

MEMBER: You mean to go into the driers wetter?

MEMBER: I don't know.

MEMBER: Forty-five years ago we didn't use any felts on our presses. They ran through bare. Then we put in a smoothing press and put felts on.

MEMBER: We use felts on all our presses that we use. On some we have felt conditioners, on others we don't.

MEMBERS: What kind of felt conditioners do you use?

MEMBER: Vickery felt conditioners with the Jordan shoes. We have no sticking with the big Jordan shoes. We had them on the other machine with the small shoes. They were not put in right, and the felt conditioner did not work right.

MEMBER: We had an interesting experience. We used the press felts and put in the cleaners. We found a marked improvement in water removal. I wouldn't venture to say how much, but we weren't able to weight them before. Today with proper cleaning we find we can weight them. The limiting factor now seems to be bearings. We use the Victory felt conditioner.

MEMBER: We are using the Victory shoe—that is, the MacArthur tops—on the second and third press. Then the Melbourne on the third press. On the third press, without the felt conditioner, we have more tonnage off the felt than those we are washing.

MEMBER: You mean it is lasting longer?

MEMBER: That is right. We are averaging 3500 on the one without the conditioner, and on the one with the conditioner we are getting 2800.

MEMBER: In the middle of the week, do you have to take the weight off?

MEMBER: No, sir, we carry the weight right through.

MEMBER: On our first press where we do not have conditioners the weight starts coming up in the early part of the week and by the time we are ready to shut down, it is practically off.

MEMBER: How much vacuum do these people have to apply with the felt conditioners? What is the range of clearance?

MEMBER: Six to nine inches.

MEMBER: Ours has been less; 2 to 4 in., except on the Victory shoe.

MEMBER: Doesn't it follow that the more vacuum you use, the less felt life you should expect on that type of service?

MEMBER: I would think so, but I don't know.

MEMBER: We have also operated a Victory felt conditioner on our second press, and we cannot go much below 5 or 6 in. without experiencing a shorter felt life. We had the vacuum available, but I have to use a breaker on it to pull it down to that level.

MEMBER: We had an interesting experience on our fourth press felt with the Jordan-type shoe. Even with 10 in. of vacuum, we were unable to weight for more than about 6 days before the felt would fill up. Then we investigated the back-hang of the rolls, and by experimenting we increased the weighting time to about 10 days. We found the back-hang to be a very critical factor in how long the felt stayed clean. The ability of the water to drain away is most important.

MEMBER: You mean the overhang?

MEMBER: The distance off center is critical in your felt life, as well as how long you can weight is concerned. We found that to be true. There is an optimum point for a felt life.

MEMBER: There is a lot of room for improving the presses by getting rid of the water which is pressed out, and not getting it back into the sheet. That applies to all kinds of machines, even the fourdrinier machines. The table rolls if you don't wipe the water off, throw it right back into the drier.

MEMBER: The whole subject of overhang is a very tricky subject, and we could spend a great deal of time discussing that.

MEMBER: Let me go off on a tangent here for a moment. In our discussion today I would like to have a few of you who are interested in a particular subject, get a committee working on it and see if we cannot investigate some of these things a little farther to find out what is known about them. We might even take one bit of it and see what we can find out about that, rather than to try to cover the whole subject.

This morning in our discussion we might just wander, which may be a good thing to do, but the only way we can get anywhere toward solving our problems is to get this type of committee working.

MEMBER: The discussion has been very interesting and we could probably go on all morning just doing this, talking about any subject that opened up. But for the over-all long pull, doesn't this committee need to begin to tabulate the operating problems on a cylinder board machine? Then, having tabulated them, to organize them in the order in which we think we might do something about them, and get people interested in those particular subjects to head subcommittees, so that additional investigations and additional work or field trials could be made on those specific subjects?

If we can come forth now with a number of subjects we are interested in, and perhaps a few less answers at this time, so that we can get an expression of interest as to what those subjects are which would require detailed investigations, you probably would get more at the end of a period of two or three years, than if we merely continue general discussion.

MEMBER: If anyone has a subject that he would like to see pinpointed, please speak up now.

MEMBER: I think we might check into the design of felts a little more closely. I have practically changed all the designs of felts that I have been using.

MEMBER: Of course we all have our individual problems. I don't think the various manufacturers of boards who are here are all the same. If you start talking news, that is one thing. The tendency today is for stronger boards. That is going to change your freeness and the formation in the vats. Then there are the vats. One mill has four vats, another has eight. What kind of vats do they have—overflow vats, or the regular conventional vats, or one half of this and one half of that? How wide is the vat? All those questions enter into it. As has been said, with the fan pump, have you got variable speed on your drier pumps so that you can get more water? Then you have blowers on the driers, perhaps. Some people have higher temperature on the first drier. So there is a great difference in the treatment. I don't think you can settle on any concrete method.

I don't think the new machines today are running the way we want them. I have a 42-in. Our problems are all different, and they vary from place to place.

MEMBER: You hit the nail on the head, because we all have different machines. Yet somewhere along the line, I feel that there are many problems which we all have in common. The basic solution for them is the same, regardless of whether we are talking about your machines, our machines, or somebody else's. The only way we will get the solution of those problems is to pinpoint some of these things here.

MEMBER: I think we will find a remedy for some, but I don't think we have a cure for all.

MEMBER: That is right. I know what a problem it is when you start talking about buying a new vat. I know we are constantly changing things, sometimes we go forward and sometimes backward.

MEMBER: You never do get a machine that is actually balanced. Either you can dry more than you can form or you can form more than you can dry. So we are never quite happy.

MEMBER: I imagine in this group there are as many different troubles as there are types of meshes of wires. In general, are you using backing wires on your machines, or single-face?

MEMBER: We are using backing.

MEMBER: We have a much more open mesh than we used to use. We use a 35-mesh wire. We make press liners and chip boards exclusively. The life is satisfactory from the standpoint that you only have one decent cloth to buy when you recover. There is a little more tendency to slip. It is harder to keep from slipping without the backing cloth. Of course, it does affect your drainage. You drain very much more freely. I don't know whether a 35-mesh is too open or not. I am beginning to think we should go to a little finer mesh, particularly on top liner molds.

MEMBER: We are doing something similar. We are using a single face. We are working toward that, a stainless steel face on our filler vat. We are using about a 40-mesh where we used to use a 50. So far we have had very good luck with the single face.

What mesh are some of you using on your top liner vats?

MEMBER: On one of our machines we have 60 mesh.

MEMBER: You are talking about white liners?

MEMBER: I mean a fine versus a coarse grade.

MEMBER: On our test liner machine we are using 30 mesh throughout, but with a backing wire.

MEMBER: We use 14. Then on the white grade machines we are using a 40 in the fillers, and have played with 50 and even 60. But 50 and 60, we will say, on top liners.

MEMBER: We are using 40 and 14 on all grades.

MEMBER: We have 50 on the top liners, 40 on other vats with a 14 backing wire on all.

MEMBER: How about the people that go to one face wire? Do they change the size of their winding wire?

MEMBER: We are using the same winding wire except stainless steel.

MEMBER: I remember a few years ago we tried the single face on the no. 1, and that rough wire caused slipping. We had to take it out when we set it up in the middle of the machine. That is the single face, 35. Then we went to 40 with a 14 backing wire. That is what I am using at the present time.

MEMBER: On our liners we use 50.

MEMBER: I still stay with the 40. I have been able to knock it out with presses, and what not. But when you get coating, that is quite a factor.

MEMBER: Are plain-weave basing wires generally used or has anyone tried to use a twill weave, or something of that order?

MEMBER: We use the plain. I don't know whether anybody else uses the twill or not.

MEMBER: We used some of the plain-weave wire rolled to knock the knuckles off the top. It sounded good, and maybe it was good, but we couldn't prove it.

MEMBER: That was on a liner?

MEMBER: Top liner, white grade.

MEMBER: How about wire marking? Did you notice a difference?

MEMBER: We think there might have been a difference but the difference was insignificant.

MEMBER: I have found a rolled wire to be superior from the standpoint of diminishing wire breaks.

MEMBER: We tried to put the wire on to reduce wire marks, but the result was not very good.

MEMBER: Weren't you running experiments last year and going as high as 60?

MEMBER: Sixty-mesh wire, yes. We have used 60, but we are using 50 now.

MEMBER: You dropped it?

MEMBER: Yes, we have gone down rather than up. We were using 60, and have gone back to 50. It seems to be a point of argument in our organization as to what we should use.

There is one thing on this subject of cylinder face on which I am curious to have an answer. On different sized cylinder molds, is there any difference in the life? Is there anybody running larger molds? We happen to have three sized cylinder molds, 36, 42, and 60. Our cylinder face life on the 60-molds is considerably less than anywhere else. They don't let go at any particular place. We did have trouble at the seams, but we solved that. Now there may be difficulty anywhere on the face where the wire pulls apart. The larger ones wear out more quickly.

MEMBER: The questions of the pH on the machine and other things are so closely related that the size is not the only thing we have to take into consideration.

MEMBER: That is true, although essentially the same grades are used on the machines. If anything, the pH test is lower on the machine with the bigger cylinders. I wonder if anybody has run into that same type of problem.

MEMBER: When you go from a 60 to a 40, do you change the gage of the wire? As you go to the 40, do you keep the same gage wire or do you have a lower gage wire?

MEMBER: In other words, is the drainage area the same or does it increase when you go down to 35? With most wires, as you go to the coarser mesh, the wire size seems to get larger.

MEMBER: As far as I am concerned, you still have more open area, more open drainage.

MEMBER: Are you sure you do?

MEMBER: I have been working on that assumption, but I may be wrong. That never occurred to me.

MEMBER: I don't think you do. It stands to reason that you should have more drainage. You don't seem to have it. Really, the drainage area cannot be the same. What speed do you run—do you run half as fast, or twice as fast? I have been wondering about that.

MEMBER: We run about 300 to 450 on the 60-in. On the smaller diameters we run 200 or 275. So actually, mileage-wise, it may be somewhat similar.

MEMBER: Isn't it just simply a matter of elasticity, that you have more wire to stretch, so you cannot get them on quite as tightly? They loosen up, and the give and take is what wears them out. The shorter the wire, the less there is of that, so it is found to wear out more quickly.

MEMBER: That was the way we felt. It is one of the things we had to find out about.

MEMBER: We are getting 8 to 15 months on a wire. I am wondering whether that is high or low in comparison to the experience of the other people in wire life. We are using a 60-mesh face, backed with a 14-mesh wire, phosphor bronze.

MEMBER: I think that is very good for phosphor bronze. I don't know whether or not we get a year out of the phosphor bronze.

MEMBER: Why doesn't the industry talk about Monel rather than stainless steel on cylinder wires? With Monel you can get a better seam. Our experience is limited, but has been with Monel wire. It seems hard in the industry to get anybody to talk about Monel wires. There are a lot of rumors that you get slippage and a lot of trouble with formation, but I don't think that is true.

MEMBER: I can't answer that. Does anybody know whether Monel has been rated too highly?

MEMBER: We use Monel facing and backing exclusively. We have nine molds, and we have used them 6 or 7 years, I think. We wouldn't have anything else, and we have very good wire life.

MEMBER: It is better in every way. I don't see any reason why it should not all be Monel.

MEMBER: Our experience on that particular one was this. We were comparing Monel to stainless. We only ran two cylinders covered with Monel, but the two lasted a shorter length of time than did the type 316 stainless which was our standard face wire. We discarded it on the basis of those two tests. Our normal life on a stainless steel cylinder mold, barring accidents, is about 2 years. The Monel faces were in, as I recall, somewhere between a year and a year and a half. The failures were due to fracture of the wire near the seam, but not the seam on a brazed joint.

MEMBER: Have you brazed your stainless wires?

MEMBER: No, sir.

MEMBER: Do you use any chlorine?

MEMBER: We have not used it for a long enough period to know whether it makes a difference or not. We are now using chlorine, but I can't say how it affects the life just yet.

MEMBER: We use chlorine, but I cannot tell if it affects the life. We use it as a slime control.

MEMBER: Stainless steel is supposed not to stand up so well to chlorine.

MEMBER: Unless you maintain a very high residual of chlorine, I cannot conceive of it having any particular effect. In our operations it is very difficult to maintain a residual of chlorine.

MEMBER: It is practically impossible on filler stocks.

MEMBER: Would it be digressing to ask a question as to whether anybody has conclusively proved that chlorine applied at the wet end is of real benefit?

MEMBER: Very definitely.

MEMBER: We have proved you need it. All you have to do is shut it off. We cannot prove its benefits, but we sure can prove we need it.

MEMBER: I would like to ask a question with relation to the deckling on the cylinders. What is the popular experience with what type of deckles or are they popularly used today? What relation does that have to the wire life experience?

MEMBER: Are there any comments with respect to the relation that deckles have to your wire life?

MEMBER: Deckles shorten the life.

MEMBER: In our experience that is where the wire fails, right under the deckles. We are using the felting, a strapped deckle. We tack it on with Monel or stainless steel tacks. There again you probably injure the wire. They have to be repaired every 10 days or 2 weeks.

MEMBER: We use water deckles exclusively.

MEMBER: There is a material that someone told me about that a mining company puts out the material and you do not have to tack it on.

MEMBER: You mean Scotch tape?

MEMBER: Who knows about that?

MEMBER: They are using it successfully at the United States Gypsum Mill at Clark Township in New Jersey.

MEMBER: We tried it. You can get it in various widths up to 2 or 3 in. It is a fairly heavy Scotch tape. As I remember it, we got in the neighborhood of $1^1/_2$ to 2 months' life on that tape, on a 36-in. mold. We are always looking for something new in deckles, because we run strip sheets off the width of the cylinder. We may have eleven cycle sheets running up the machine. Our deckle widths change from order to order, and day to day, so we are looking for something that is easily put on and easily taken off. We thought that would be the answer, but we did not get the life on it that we anticipated.

MEMBER: We found a pretty good substance for painting deckles. You don't have to change them very often. You put on a du Pont glue and it works out very nicely.

MEMBER: When I started in the paper game, I started on a tissue cylinder machine. We have used the lacquer deckles. That was the popular way of putting on deckles in the '30s.

MEMBER: Has anybody else been using water deckles?

MEMBER: We have been using them for 50 years. I always wonder why anybody uses anything else.

MEMBER: That is an interesting thing to me. We have always used them, and all the mills I have worked in have used them. Why use the other type? I am curious. What is the theory behind using the strapped deckles?

MEMBER: We may change deckles four or five times a day. If we had anything but water deckles, we could not do that.

MEMBER: If you are deckling in on a particular mold very far, then it makes a difference in the amount of stuff you are getting off. Our practice is to use a cloth deckle part way, and finish it with water deckles. It gives us the adjustability without getting a wide open space where you are peeling off a lot of stock.

MEMBER: We paint the edge you cover.

MEMBER: The reason we started to work on the deckle problem was the fact that we tried to get every inch we possibly could, due to our narrow width machine. First we used just cloth; then we started to solder on a copper strip which comes out of a cable, and that didn't pan out too well. Then we hit upon this so-called glue. The only trouble we have had with that is that it is a paint. It is so thin that as it is put on the cylinder it is apt to be rather ragged. To prevent it, we have a little gadget to push the stock back onto the wire again so that it is $^1/_8$ in. from the deckle to the paper. That prevents that rough edge on the edge of the mold. If you don't push it back, it is so rough on lightweight sheets, that when it gets up between the second press and the driers it is apt to break.

MEMBER: We have not had much experience with the water deckle, except the type you mentioned. How far in do you run them when you trim them?

MEMBER: Our widest sheet that we make is 90 in. Our narrowest is 60.

MEMBER: And doesn't that affect it?

MEMBER: We have overflow vats which probably make a big difference.

MEMBER: We don't deckle in on our machine. We run a constant deckle, except when we take care of a felt or get a bad edge on a felt, and have to deckle in temporarily. Our theory, right or wrong, is that we cannot run a narrow deckle or we ruin our press rolls or calender stacks.

MEMBER: Our water deckle is a pipe that runs across the machine with a slot in it. It has a plunger which moves in and out. The machine tender varies the slot length merely by pushing this plunger in and out.

MEMBER: How do you clean your bottom felt? That to me has always been an interesting problem. What is the consensus of opinion on high pressure showers for cleaning felts and cylinder wires?

MEMBER: We use high pressure, about 125 lb. on the bottom felt. We also have high pressure in the Scoffield that we use on the bottom with around 500 lb. of pressure, occasionally.

MEMBER: What is the distance from the tip of the jet to the felt?

MEMBER: About 3 in. With us, keeping the felts clean is a major problem. We have no top felt. We have a plain extractor and a section extractor. To get the sheet through the first press, you must raise the press when you run it. It isn't driven. So you have to pick it up a little to get the sheet through.

We make some lightweight chips, and unless you can keep it clean, there is trouble.

I don't think it has anything to do with shortening the life of the felt at all. We ran before with very low pressures, and the felt does wear out just from travel. I am prejudiced against the felt. The felt is only there to carry the sheet across the machine, and the day you slow down 10 or just 1 ft., cut if off, it's done.

MEMBER: I think that is the consensus of opinion. This idea of getting a long felt life isn't the answer to the best production.

MEMBER: What is the design of the Scoffield?

MEMBER: It is the regular nozzle that the Chain Belt Co. puts out.

MEMBER: Does anybody use the Broughton high-pressure showers by themselves?

MEMBER: We have a Broughton felt shower with a fan spray operating at about 85 lb. pressure, followed by a whipper, then the deluge shower.

MEMBER: You have to have the deluge shower with it.

MEMBER: The Broughton is a moving shower.

MEMBER: We have the same type. I am using 110 to 120 lb. pressure on the Broughton, ahead of the whipper, followed by a recycling shower, a deluge shower. Incidentally, we are operating one of these local water systems. On our no. 1 machine we use the OCO clarified water for cleaning our felts. We had considerable difficulty with the Broughton design that we had installed. There is a projecting nozzle which does not fit into the shower base. It projected half or three quarters of an inch. We got a deposition of dissolved solids in the nozzles, and after 2 or 3 days' operation, they were doing little or no cleaning.

We have gone to the Walsh type, and it works splendidly, the same shower pressures putting 18 or 20 g.p.m. of water per shower on a spray surface of 96 in.

MEMBER: How many gallons did you say?

MEMBER: I have a water meter on one of them which runs between 18 and 19 g.p.m. The pressure is 110. That is for the shower. It is 96 in. of sprayed surface. I think they are on 4-in. centers.

MEMBER: We are supposed to run 2 g.p.hr. per jet, at 50 lb. pressure. I can't tell anything about anything higher than that.

MEMBER: We have an oscillating shower on a chip machine, using fresh water. We had the high-volume showers previous to that. We have taken them off and are using the oscillating showers alone. They have cut the fresh water consumption 50%. Usually they run satisfactorily. There have been occasions where the operators have put the one high-volume shower back on near the end of the felt life, or operating cycle.

There is a good question right there: is it better to try to operate with high-pressure and low-volume fresh water, or high-volume low-pressure white water?

MEMBER: I'll grant you that is a tough question. I think it depends on the stream pollution.

MEMBER: To get back to the question of felt life, a very interesting paper was presented by the Albany Felt representative at the Delaware Valley Section meeting last year. I think it was written up a couple of months ago. Some of you fellows might be able to get information on felt life out of that.

MEMBER: Somebody the other day at the meeting recommended getting away from whippers. I asked him to come here because I thought we could get a good argument.

MEMBER: We use all Broughton showers on both felts and cylinder molds. On the felts, it has been our experience that the Broughton does not give enough water to give good washing action to the felts. We have found that by using a shower with lower pressure, but flooding the felt along with the Broughton showers, we get a good cleaning action. When you get to the cylinder molds, they do an excellent job in keeping clean. We don't know what it is to have dirty cylinder molds.

MEMBER: Well, we do.

MEMBER: On Broughton showers on felts, we started in with the Broughton recommendations, and found that we

did not have enough water to keep the felt clean. We had to flood the felt and do various things. Then we decided that maybe the Broughton people tried to go too far all at once. We have found you can use the Broughton shower with any sized hole and we have gone up to as high as 0.062 in. on some openings with Broughton showers, and plenty of water.

MEMBER: We have found that, too. We have gone into the new type nozzles which they have on the felts, because the nozzles won't plug up. They had the protruding type, then the receding type. We had very little trouble with the new type nozzles plugging up.

MEMBER: We have recently put Broughton showers on the wires and Broughton showers are ordered for the felts. We hope the showers for the cylinders will do a very good job. They are doing a pretty good job so far but are still not keeping the deckle edges clean. We have a very peculiar water problem where we are. Years ago the Broughton representatives were around to see us with their showers. We tried them out, as we do most everything else, but they didn't work. We have a very difficult problem in that the edges fill up next to the deckles. What the final solution will be, I don't know. We have this precipitate coming in between the winding wire, the backing wire, and the facing wire, and it is a little difficult to get it out. The best way is to take the cylinder out and work on it at your leisure.

MEMBER: We have the same problem during certain periods of the year.

MEMBER: I would like a little first-hand knowledge on it, if you have it. Or if you have any solution, I would be interested.

MEMBER: We have that same problem periodically. We have it at certain times of the year with certain stocks, and we cannot find out what the difficulty is. We will start on Monday morning, and within 4 to 6 hr., the deckle edges are completely closed. It is the same as a taped deckle, and you just stay that way. We finally got rid of it on a weekend with a shutdown. We sent the Dowell Co. a sample of the wire and a sample with the stuff in it. They have worked on the problem and come up with an inhibited acid of some description. I don't know just what kind it is, but it cleans the wire, which is more than we were able to do before. We were using muriatic acid for wire cleaning, and it couldn't even touch it.

MEMBER: Does it clean all the hard material out between the layers?

MEMBER: Yes, it appears to do a very good job of cleaning. We put it in and turn the mold around, but if it gets very bad, they come in and steam it once in a while.

MEMBER: Does it do damage to your wire life along the edges?

MEMBER: No worse than the muriatic acid we were using.

MEMBER: We have had that trouble on the deckle edges, especially on the top liner molds. We came around to the Wyandotte A and E. You boil that. You put the solution of about 6 oz. of the material in a 5-gal. drum, and merely pour it on the edges of the molds. We brush it and cleanse it. We do it every time we shut down.

MEMBER: How many have tried the hydro-silicate pumps?

MEMBER: We use it for cleaning our pipe lines.

MEMBER: We use it on the felts. It does a good job. If the felt begins to fill up, you can use it.

MEMBER: We use the hydro-silicate pump. It is always out of order. It costs too much for maintenance with us.

MEMBER: I think that is the same experience everyone has had.

MEMBER: I think it is essentially a matter of hard water deposits built up on the cylinder face. We have found Oakite 32 does a beautiful job. It is an inhibited acid.

MEMBER: That is probably the same thing as the Dowell material. I am sure it has some sulphuric and some muriatic acid in it. Is everybody using an acid for cleaning felts on weekends?

MEMBER: We have found on our press felts that we can use the same material as we use on the cylinder mold after we have shut down, rather than cut that felt off. We use the same solution, the same proportion, and wash it down. It does a fine job. As a matter of fact, we can get up to 4 weeks' wear by doing that and get very good drainage, and we have no trouble at all. It is Wyandotte A and E. It is put out by the Wyandotte Chemical Co.

MEMBER: A place we have had trouble in the past, and still do occasionally, is with our suction rolls filling up. I don't know whether it is common to the industry.

MEMBER: We had that trouble, too, and found that it was aluminum oxide.

MEMBER: Do you back flush it when you shut down?

MEMBER: No, we don't.

MEMBER: You just shut the valve. It is a reverse operation. We licked it by cracking the box a little bit by moving it ahead, so it is just past the nip point. You can also hear a little air coming through as though the cell were just being slightly broken, and we have had no trouble since we have done that.

MEMBER: On one machine, purely by accident, we started putting a soap that we use for washing our felts, a detergent, on the roll. If there was a little soap, we left the suction roll on and ran it. If we were down 24 hr., we leave it in the suction roll. Our troubles seemed to disappear, apparently through soaking it up and leaving this soap and acid in there. We got completely away from that filling trouble.

MEMBER: Don't you think it decreases the life of a suction roll?

MEMBER: I don't know. The last one lasted 15 yr. We have just had it changed. We have a good thick cover.

MEMBER: You mean rubber?

MEMBER: No, the shell. The bronze shell.

MEMBER: We tried that. Our shells were very badly damaged. I would like to hear more about the back flushing. Are you talking about white machine grades?

MEMBER: You don't get fiber deposits in the hole?

MEMBER: We back flush when we shut down.

MEMBER: Does this mean you can run indefinitely with clean holes?

MEMBER: On the next cycles, yes.

MEMBER: You don't have to stop?

MEMBER: We take the rolls out once every year and recondition the drums on both machines.

MEMBER: When you do that, are the holes full?

MEMBER: There is a deposit that is built up, but not enough to give trouble. We do it more as an insurance measure than anything else.

MEMBER: How long a back flush cycle do you run?

MEMBER: It is done for about an hour after we shut down.

MEMBER: I think a lot depends on the water, if you get a bicarbonate water you have trouble.

MEMBER: It is not the water but what is in it.

MEMBER: We have a little box on our suction wall. The only thing you can do is drill it. Acid will not affect it.

MEMBER: Is anybody using hot water for his felt showers?

MEMBER: We use cold.

MEMBER: On the closed water system in our mill, it gets to around 130°, and the Scoffield showers we use have a mixing valve with steam. We heat that water to around 150°. I don't know if you call that hot. It is not quite boiling.

MEMBER: That is pretty hot for felts, as I understand it.

MEMBER: It does not bother us. Our felt life is getting better all the time. We are putting bearings on our couches and felt rolls.

MEMBER: We use hot water on the Scoffields, with steam injectors, and run them very hot. You couldn't keep the felts clean without that. Those are not the only showers we have. We have regular showers at the whippers. We are talking about wet felts now, and the Scoffield conditioner is

just an additional cleaning device over and above the normal shower and whipper combination.

MEMBER: What do you use for temperature?

MEMBER: We use hot water.

MEMBER: If you are running hot stock, you have the advantage of not cooling your molds off.

MEMBER: Is there anybody that does run without a whipper?

MEMBER: I don't know of anybody. This man made the comment, and I am interested in his theory. I would agree, if you could get away from them, it ought to be a very good thing.

MEMBER: He is also running without a mixing box, I think he said.

MEMBER: Well, I will go along with that.

MEMBER: Why would anybody want to run with a mixing box?

MEMBER: There is a question you might want to discuss.

MEMBER: I guess nobody thought to take them out.

MEMBER: I think there are a good many mills that are getting rid of mixing boxes.

MEMBER: We have kicked this around, and I don't know whether we are convinced or confused. What is a good machine that will run chip, a white coated board, and everything?

MEMBER: There hasn't been one made yet.

MEMBER: What is the ideal machine that will make anything, 16 point, white board and coating, up to 40 points?

MEMBER: You're going to get that when you get to heaven.

MEMBER: I think you have got a point there.

MEMBER: I think we ought to segregate the grades.

MEMBER: I think you are right. It is unfortunate that we have to run a wide variety of grades, which complicates your problems substantially.

I would like to be able to answer the question on the machine, but I'm afraid I can't give you any final answer.

It is like the question, what do you think is the ideal press section on a machine? I know you all have a lot of ideas on those things, but what should the combination of suction and size of press rolls be?

MEMBER: I would like to ask a couple of very elementary questions. What is the best way to dry a top felt before you take it into your press section, outside of the system of taking it off entirely?

And the second question is, how much effect do the overhang couch rolls on a cylinder machine have on the moisture content of the web?

MEMBER: Let's take those one at a time. First, what is the best way to dry up the top felt?

MEMBER: I don't know whether there is any difference on a top or bottom felt. As you increase your speed, you have to put on more vacuum boxes on the bottom. We started with one, and now we have three and we could use a fourth. You can see the additional water running out of them in the tanks; we can check it all the time. If you are going to run fast, you have to get the felt dry.

MEMBER: How wide would you say the section is?

MEMBER: The boxes are three-eighths. The speed you use would make a difference.

MEMBER: Where do you have the boxes located?

MEMBER: Just ahead of the first cylinder. We have it come up and straight into the first cylinder. But that is the way the machine is set up.

MEMBER: You have a three-eighths slot? That sounds very, very narrow, compared to what most of us are using. With that three-eighths slot, how much vacuum do you carry on a box?

MEMBER: We have about 12 in., but one thing we did find out. We thought the narrow slot was silly so we opened it, and found that it was worse. We were better off with two or three narrow slots than one wide slot.

MEMBER: You have more felt drag.

MEMBER: The other thing is that with one wide box you will notice sometimes a felt will run with a wet streak. With two or three boxes, you will dry that spot.

MEMBER: We have a pair of squeeze rolls and one box.

MEMBER: We had them in and took them out. They always wear on the edges.

MEMBER: Does anybody else have more than one box, either ahead of or on the top and bottom shelf?

MEMBER: We use a roll in the beginning on top and on the bottom. It is a suction roll.

MEMBER: We are using a straight squeeze roll.

MEMBER: You can use it, depending on how you run, of course.

MEMBER: For high-speed operation we have been unable to dry the felt enough with the suction roll, but the suction roll does a nice job to begin with—then hit it with the box.

MEMBER: What do you think about putting a suction roll down at the bottom? Do you think they would pull enough water?

MEMBER: It could be. We have not done that, however.

MEMBER: We have thought of doing that.

MEMBER: It seems to me that there is some kind of air velocity through the felt with the clean water. If you have a wide slot, you will have to pump more air through. The narrow slot box is more economical, and that is what you are after.

MEMBER: When you put the second box on, the volume of air handled is so great that the vacuum pump we had on the box would not swing it, so I put two boxes with $^3/_8$-in. slots on.

MEMBER: Even three-eighths is wide; get it down to $^1/_4$ in. Get the velocity up. You have to get the velocity up.

MEMBER: I think the answer is that a narrow box is more effective if you increase the air velocity through the felt. The narrow slot, I should say.

MEMBER: How many people have constructed suction boxes from micarta or Ryertex covered pipe?

MEMBER: We do, and we like it; it is very good.

MEMBER: We put suction felt rolls on one of our machines. We took all suction boxes off completely and found we had just as good results.

MEMBER: How high a speed do you run?

MEMBER: 260 ft. We have had good felt life all along and it has not been decreased any. They have been on since the Christmas shutdown.

MEMBER: Has anybody put this micarta top on the box with a fairly wide opening but with diagonal supports so that you can carry increased vacuum and still not have too much drag? I understand that is being done.

MEMBER: We have used a flat box for years, with diagonal openings in them. The box is 4 in. wide. The old conventional style, I guess. We have never changed. Our vacuum pumps are too small. We probably only get 3 or 4 in.

MEMBER: I wonder whether that would be the trend, or whether the trend is toward reducing the actual number of boxes you would use.

MEMBER: I think the trend is the other way, to put on more, and to hit it more times.

MEMBER: Isn't it a question of adding to the bearing area that your felt is riding on? You want the minimum bearing area in order to maintain the minimum felt drag. It seems to me with a box constructed with a cover made such as the kind you are speaking of, you would have more felt bearing area than you would with a narrow slot with only perhaps an inch lip on each side, or less.

MEMBER: The type of box we use would be equivalent to about an inch-wide section, I would say.

MEMBER: Has anybody investigated or used this English design, the rotor belt, as I believe it is called, for felts?

MEMBER: We heard of somebody who tried it. They had a lot of trouble with the beams.

MEMBER: The suction box problem should not be very

different between the cylinder machine or any other. There have been advances, particularly in Canada, on the suction box for the fourdrinier. In the work I have done, I find they have so many inches—3, 4, 5, or 6 in.—vacuum at one end, and 2 at the other end. The pneumatics and hydraulics of the problem have not been worked through.

Another point is that you are running a felt or a wire over your holes or slots, and your moisture starts to go down and it hits against the vertical wall. When you do that, half goes up and half goes down. We made tests on suction box covers, drilled at 30° angles, which is very difficult. These were rather crude wooden-topped boxes. We found for half the vacuum we took out the same amount of water as we did with a straight up and down slot. That meant pressure could be less for the same amount of water, and the life of the wire would be decreased appreciably. You put them on an angle. That shot the water down instead of hitting the wall. W. E. Greene has a partial patent. If anybody is interested, I think he would be willing to go into it further.

MEMBER: That sounds reasonable. I know of one mill in particular that has been talking about speeds that are getting up comparable to at least the minimum speed fourdriniers. I think a lot of cylinder machines you have are running into that, including ours. Our problems have changed from a slow-speed to a high-speed operation.

MEMBER: On the Ryertex overlay on a suction pipe, you can cut the under side of your lip and more or less gain the same advantage that was just mentioned.

MEMBER: In this respect I would think the pipe you fellows use would be much better than a flat box where you would have a square opening.

MEMBER: We have a ventura type of suction reel. That is similar to the Scoffield. We made them ourselves.

MEMBER: How do you get tar and chewing gum off the no. 1 cylinder face? I wonder if there is some method of getting that stuff off.

MEMBER: We used to get it so bad that we had to go to single faces. We use 20 or 24 on the cylinders, so I didn't mention it, but we had used a 40 and 14. We got so much tar between them, we couldn't run. We used to get kerosene and use that. If you put it in no. 1, it cleaned the other. If we put enough kerosene, it raised the rolls and did the job.

You really have to clean the felt. It really did a good job of cleaning the felt of tar. We usually wash it off with a little soap and water.

MEMBER: I understand that there are companies who are not using acid or soap, but are using a solvent type entirely for cleaning wires and felt.

MEMBER: There is something the Sun Oil people use, but we do something that is perhaps a little different. We spray kerosene continuously on the bottom felt. We have a setup right after the felt comes out of the first press, and we spray it on there. When you get through the showers, it is washed out. You get no carry-over, yet it will clean the tar off.

MEMBER: We have played around with a number of solvents. Magnus has one, no. 799, which is very volatile and is flammable. You want to try it on a shutdown. You close the gate at the bottom, put water in, take the felt off. I say that because we had a sad experience when we put in 10 gal. of the stuff and rotated the cylinder. Turn on the showers when you are done, and flush it out thoroughly, for about an hour. It usually cleans it up.

Great Lakes Solvent is another. Another is Solvent 21 and Solvent 22. I believe it is a product of Socony-Vacuum. That will do a pretty good job.

MEMBER: We took off backing wire and put on single face, and we don't spend our Sundays scrubbing that first mold any more. They don't get dirty.

MEMBER: You are gambling when you use petroleum solvents. A petroleum solvent is liable to damage your couch rolls.

MEMBER: If you have any natural rubber, and you use it once, you can regrind the couch.

MEMBER: We don't have any trouble with the couch roll. You wash it off well. If you let the kerosene stand on it, you have to wash it off. We have had the same couch rolls on for a long time, and have not had them covered in 5 years.

MEMBER: The rubber companies shudder when you tell them you are using kerosene.

MEMBER: They do frown on it. Will anyone comment on the overhang on couch rolls?

MEMBER: What effect does the overhang on the couch roll have on the moisture content of the sheet?

MEMBER: Offhand, if you did not get the correct overhang, I can tell you from our experience that it isn't the couch roll but it is an extractor. I have been having a little trouble keeping faces on extractors for the past six months. Before that I was getting maybe 8 months to a year. Two things played a part in it, I think. One was that the rubber was getting hard on the couch rolls—at least that was what I thought—and I got a soft rubber under the extractor couch. The second thing was, I think I had a little too much overhang. I moved the roll back; took it about $^3/_4$ in. back. I still have $4^1/_2$ or 5 in., but I have not noticed any difference in the speed of the main or any effect in the press section by changing the overhang. It looks now as though I am going to start to increase the life on the extractor. This one happened to be 23 or 24-mesh.

Speaking of extractors, I might bring out one other point. Someone mentioned coating earlier. Maybe you fellows have machine coating. You know you have to have a fine wire. I was a diehard, and I knew I could get a better finish if I took the 23 or 24 off, and I put a 40 or 50-mesh wire on the extractor. My first thought was that on an extractor you have trouble in keeping them clean when you go to two wires.

I came up with this solution for our problem so far. I have put two Broughton showers on it. I run the extractor in water continuously. I use Magnus 94-XX every weekend. I run the water in the extractor pan about 120°, and we turn that extractor for about 45 min., very slowly.

It must be 3 months ago since I changed over and, so far, I have not had a dirty extractor during the week. But we do that every weekend.

MEMBER: This problem of smoothness on coating is really quite a problem. The amount of trouble seems to vary with the process. One time I did work on a Champion coater, and at the present time we have a roll coater. The problems in getting a good finish are quite different.

MEMBER: We have a Champion coater. We can't even use heavy weights on the extractor because it would carry through on the coating. In coating you bring up any defects you have on your sheet. On the third press felt, that press takes out normally from 3 to $4^1/_2$% moisture. On coating you have to ease your weights up on your third press.

MEMBER: We have been fortunate in that our reverse presses are our second presses. Our third press is the top side of the sheeting and is hit with a plain roll.

MEMBER: Do you get enough out so that it doesn't show felt marks? I am thinking of very fine printing.

MEMBER: We print about 120 screen, if I am not mistaken. It is a fairly fine screen for letterpress printing.

MEMBER: I don't think the overhang on the plain extractor had any effect on the amount of water removed. Is that true on couch overhang? Is it true that couch overhang does not have anything to do with water removal?

MEMBER: We have looked at that, and our conclusion—somewhat indefinite because of lack of ability to definitely put the finger on it—is that the data show that the couch overhang affects the likelihood of crush, but not moisture.

MEMBER: Is it hard to try to figure moisture on something like that?

MEMBER: It seems to me that the moisture you take out

with your couch roll that is at the top end—you have a lot of water, especially when you have suction drum rolls on all your machines. We almost always, regardless of what we do, come down to a certain percentage, leaving those rolls. That water is easy to get out. Until you get down to around 25 or 30% solids, you have a tough problem of water removal. Almost any way we run our suction drum rolls, we come down to 25 or 27% going through them.

All our section drum rolls have two rolls on them, or they will have shortly. One does not have it now, but we will actually have three section drum rolls in three different setups.

On one we have a side suction roll, one a plain side roll, and another just a top roll. All of them have top rolls. We get a lot of water out with a suction drum roll. By having the side rolls, we give it just enough pressure on the side roll, whether it is a suction or a plain one, so it gets the sheet a little compact. Then we can weight it heavily on the top roll. We use a pressure of about 150 lb. per in.

MEMBER: We use a hundred.

MEMBER: If you use a side roll, it presses the top felt against the roll; that is what I meant. We have a side roll at the side, and our top felt comes over that. There is a high and low vacuum area on this section roll. We have three different sizes. I think the largest of the rolls is 30 in. with a high and low vacuum area.

MEMBER: If you have a six-cylinder machine, you have six sheets of paper. If you go too far back, you probably have poor bondage. The upturning plies are not wet enough to bond.

MEMBER: Is there such a thing as bonding too much on a folding grade?

MEMBER: I don't think so.

MEMBER: I am not sure there isn't.

MEMBER: It is a question of what you are after. If you want good bonding, if you go too far back, it is not going to be good enough. If you go too far up, you are liable not to get enough water.

MEMBER: I have seen the sheets of some of our competitors with poor bend. Normally, in a good bending sheet on a folding grade, if you look at it after it is scored, part of it goes in, part of it goes out. On the sheets I have seen where you have poor bender, invariably there is no separation in the sheet when it is folded.

MEMBER: That is true on certain orders, but there are others that require pretty husky bonding.

MEMBER: I don't know how to measure it, but if you get a poor bender when you have a good stock in, you don't get a ply separation.

MEMBER: The thing is, where is the saw-off point there?

MEMBER: I think as close to your top as you can break it conveniently is the best place to do it. Your normal sheet will split up between the filler and the underliner.

MEMBER: Aside from the beater room, what conditions affect plybond?

MEMBER: What conditions don't affect plybond?

MEMBER: Is there a difference on counterflow or straight flow in the plybond? I mean, if a machine has counterflow, does it have better plybond than straight flow?

MEMBER: I don't know. Does anybody here have two machines, one with direct flow and one with regular flow?

MEMBER: We have as many as three direct flow vats on one machine, bonding on counterflow vats. But I am not the person to discuss it, because we have no more plybond trouble now than we have ever had.

MEMBER: Do you notice any difference—that is, which forming gives you the better plybond?

MEMBER: No. Actually we cannot put it down and say whether it is or is not part of the trouble. A direct flow vat with an overload on it will cause the plies to come apart beautifully. But that is a matter of tight formation and so forth.

MEMBER: Do you think your suction drum has any effect on that, on your plybond, because you are drying your sheet up after it goes into your press section. Would that have a tendency to loosen it up?

MEMBER: You people operating your suction rolls are getting your sheet as dry or drier than any of us who are operating drum presses. We have changed to drum presses for wire marks, and we have found that our sheet did not get dryer, but was wetter.

MEMBER: Did you notice more trouble afterward in the plybond?

MEMBER: I wouldn't say that.

MEMBER: Your trouble in plybond is between your stocks. Is that so?

MEMBER: Not necessarily. We are having ply separation troubles between fillers as well as between fillers and independent liners.

MEMBER: You mentioned the fact that you can get into trouble by having too good a bond.

MEMBER: That is just my theory. I would not guarantee that it is right.

MEMBER: I am inclined to agree with you. But how did you arrive at that conclusion?

MEMBER: How do you get too good a bond? Well, that is something I would like to know, and I would like to know how to correct it. In some ways I think it may be the machine characteristics, because we have one machine that is more prone to do it than others. We cannot produce as well as we can with our other machine.

MEMBER: On one of our machines we do not have a top felt. On the other one we do. On the one without a top felt, we don't get as tight a bond between molds as you do on the one with the top felt. That is definite. You can see that, although we do not run into trouble, except on the heavier weights, on the machine that does not have a top felt.

MEMBER: On the machine which gives us a poor bender, I don't think we have had any ply separation. I have never seen it on there.

MEMBER: You have an overflow vat?

MEMBER: Ours are all counterflow.

MEMBER: If you try to overload on an overflow vat, it will split within the ply. I have seen that happen.

MEMBER: We don't seem to get splitting. I wish we could get just a little more on that machine.

MEMBER: If you are running one cylinder, it will split itself.

MEMBER: In respect to our ply separation problem, I should have said that we never had ply separation between two direct flow vats when they were running the same stock and were not overloaded.

MEMBER: On overloading, they will split.

MEMBER: You bet they will.

MEMBER: We have had that on our small cylinders; where we have had six cylinders and overloading, we can get a split very easily unless the stock is just right.

MEMBER: We had a uniflow vat, our no. 7. We have turned it around to make it a counterflow to get away from ply separation. The sheet looked all right, but with glossing there was a definite pulling of the liner. It just peeled right off. I think we have been able to put more stock on the cylinder as a counterflow vat. We got back to good bonding at the top by turning the vat around and making it a counterflow vat.

We are still playing with the design, and it was quite a job. The formation was beautiful on a direct flow, but it just would not bond.

MEMBER: It is possible that formation has more to do with it than anything else. In order to get formation, we put "dandies" on the cylinder in the vat. As the stock came up, it came under a dandy roll. That smoothed it down and made the most beautiful formation you ever saw. But with four cylinders, we got four sheets.

MEMBER: I wonder whether it is a question of dryness or formation.

MEMBER: It could be either one, but it still was plenty wet. We had as much water back of the couch roll, but apparently the formation was very good and there wasn't any curl.

MEMBER: There is one thing I would like to mention, because I will not be here for the discussion tomorrow. Maybe it is just a condition I ran into in the mill. I would like to ask whether anybody else has a Vortrap on their top liner stop? We have put in Vortrap on a top liner stock. Have you noticed any difference in the preparation of your stock?

I will just give you this for what it is worth. The first Monday we started up the Vortrap, the boys had trouble with overjordaning stock on the regular rate they had been doing for years. I found that by taking the jordans off halfway, you could form up your sheet. But it is impossible to set our jordans up anywhere near where we had them before. We don't seem to be able to find too much change in freeness, but we do get a radical change of the stock passing through the Vortrap, and the Vortrap is hooked on ahead of the screen. It returns the stock back to the screen. The screen has very little work to do except to take our large, light, floating material, if they happen to be present.

On bleached manilas, you can pass it through the jordan and set your refiner up about halfway, and you have a better looking sheet, a different feeling sheet, and of course you have got to include bender by doing that. The pick test, to my amazement, is still good.

MEMBER: I never heard of that. It could be that you are breaking your fiber bundles up into fibers, so that you have got a better stock to operate with.

MEMBER: I would say offhand we must be saving at least a minimum of 25% on the jordan; at least that much. I thought I ought to say something about it. I don't think any of us have too many secrets among ourselves. This is an 8-in. Vortrap, and the second is a 3-in. Vortrap. If you think about it, you have your stock going in at a high velocity because of a reduced orifice. You can get a whipping action coming down through a Vortrap, and you probably get a separation of the fiber. There is perhaps a little hydration in that.

If you are considering Vortraps, think of that. If you get one in, don't set your jordans up on the floor.

MEMBER: I am pleased to hear you say you have put a Vortrap on the top liner.

MEMBER: We have it on one machine, and it will be just a question of time before it is put on the other machine. Because where no. 2 machine has been making a nice clean sheet up to now, no. 1 machine has gone right on past it. On chip stock, it is amazing how much dirt comes out. Your chip no longer has large, dirty specks in it. It looks clean, and it is a different type of formation.

MEMBER: What horsepower is required for the Vortrap?

MEMBER: Two horsepower.

MEMBER: What is your pressure?

MEMBER: Between 18 and 20 lb. Discharge pressure is about 5 or 6 lb.

MEMBER: What size Vortraps do you have?

MEMBER: Nine inches. I understand the Vortrap people are coming out with a little better than 8 in., which is 6 in. with a secondary unit.

On chip you definitely get bark. At least I would say it is bark, although I did not put it under the microscope.

MEMBER: What is your through-put?

MEMBER: In tons per day, about 25 tons. But of course, I have been more or less in favor of Vortraps for a long, long time. I believe in them 100%. We have them on the fillers. I have another one to put in, and I hope to buy still another.

I might say that your Vortraps have to work, in order to get efficiency, about 0.5% to 0.75% consistency. That is where you get your maximum efficiency in taking dirt out.

PRE-BEATING

WITH

HERMANN *Improved* CLAFLIN

"Continuous Beater & Refiner"

FOR SALES GRADE PULPS OR FOR OWN CONSUMPTION

INSTALLATIONS: SULPHITE-KRAFT PULPS, (BL. & UNBL); BLEACHED SODA PULP

Fifteen years ago a small Kraft Pulp Mill used a No. 1 Claflin Refiner on washed pulp ahead of screening. Washed pulp to Claflin to screen with accepted stock to wet machine chest and screen rejects back to digester and above cycle. Result, pulp required less time and power to repulp, beat and process than with other pulps.

SPECIFIC OPERATING INFORMATION FURNISHED UPON REQUEST.

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Acid-Insoluble Lignin in Wood Pulp*

Corrected TAPPI Tentative Standard T 222 m-50

THIS STANDARD IS UNDER THE JURISDICTION OF THE CHEMICAL METHODS COMMITTEE

When wood pulp is treated with strong acids the carbohydrates are hydrolyzed, leaving an insoluble residue which is determined as lignin. A preliminary extraction with alcohol-benzene is recommended to remove resins, which, if allowed to remain in the pulp, would remain insoluble with the lignin.

Chemical wood pulps, especially sulphite, may contain materials which are derived from the lignin originally present in the wood, but which are not insoluble under the treatment employed in this method. Therefore, the values obtained for acid-insoluble lignin should be regarded as minimal values for the lignin content of chemical wood pulps.

For Lignin in Wood, *see* TAPPI Standard T 13 m.

APPARATUS

1. *Filtering Crucibles.* Alundum or porous porcelain (both of fine porosity), or Gooch crucibles with an acid-washed asbestos mat, are recommended for filtering the separated lignin.

2. *Extraction Apparatus.* A Soxhlet apparatus is preferable, consisting of (a) Soxhlet extraction flask, 250 ml. capacity; (b) Soxhlet extraction tube, inside diameter 45 to 50 mm., capacity to top of siphon approximately 100 ml.; (c) condenser; (d) extraction crucibles of alundum or fritted glass and of coarse or medium porosity. The extraction tubes specified siphon more rapidly than extractors with higher siphon tubes.

REAGENTS

A. *Alcohol-Benzene Solution.* Mix 33 volumes of approximately 95% ethyl alcohol and 67 volumes of C.P. benzene.

B. *Sulphuric Acid, 72%.* Carefully pour 665 ml. of conc. H_2SO_4 into about 300 ml. of water and, after cooling, dilute to 1 liter. Standardize against standard sodium hydroxide solution, using methyl orange indicator. Adjust the acid to a strength of 72 ± 0.1%, by addition of water or conc. H_2SO_4 as may be found necessary.

Note: As conc. H_2SO_4 varies somewhat in strength, the measurement does not have to be made accurately; it may be done with a liter graduate. The proportions given are for conc. H_2SO_4 of 96% strength and 1.84 sp. gr.

If desired, the solution may be standardized by an accurate determination of its specific gravity. For 72% H_2SO_4 the sp. gr. at 20°/4°C. is 1.6338; and at 60°/60°F. or 15.56°/15.56°C. it is 1.6389. A variation of 0.1% in the strength of acid at this concentration causes a change of 0.0012 in the specific gravity.

TEST SPECIMEN

The test specimen shall consist of a representative portion of the pulp which has been thoroughly air dried. Any large pieces should be broken down by disintegration or torn apart by hand.

PROCEDURE

Weigh accurately two samples of pulp of approximately 2 grams each for the lignin determination. Weigh at the same time two samples of approximately 1 gram each in glass-stoppered weighing bottles for determination of the moisture content. Dry the moisture samples in an oven for 2 hr. at 100 to 105°C., replace the stoppers, cool in a desiccator, loosen the stoppers to equalize the pressure, and weigh. Continue the drying for 1-hr. periods until the weight is constant. (If preferred, the moisture samples may be dried overnight at 100 to 105°C. and a constant weight assumed.) Calculate the percentage of moisture-free pulp.

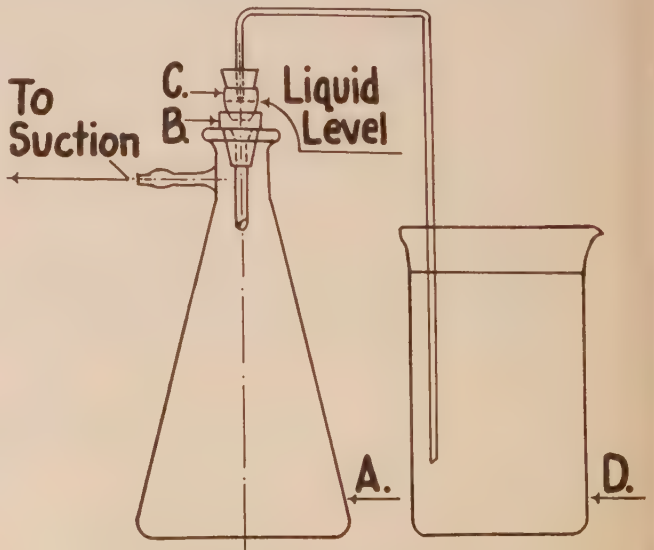

Fig. 1. Apparatus for lignin filtration

A, suction flask; B, crucible adaptor; C, filtering crucible; D, beaker.

* This method has been approved as a tentative standard by the Standards Committee. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

Transfer the lignin samples to extraction crucibles, place in a Soxhlet apparatus, and extract with alcohol-benzene solution according to TAPPI Standard T 6 m. After completion of the extraction, spread out the sample and let it dry thoroughly in the air.

Note: In the case of semichemical pulps, a hot-water extraction may be necessary to remove any residual cooking liquor. This extraction should be made and the sample air-dried before the extraction with alcohol-benzene.

Transfer the air-dried sample to a glass-stoppered weighing bottle or a small beaker with a watch-glass cover and add slowly with stirring 40 ml. of cold (12 to 15°C.) 72% H_2SO_4. The sample must be well mixed and freed of lumps by stirring constantly for at least 1 min. and longer if necessary. Allow to stand at a temperature of 18 to 20°C. for 2 hr. after the pulp has completely dispersed in the acid, with frequent stirring. A water bath may be necessary to keep the temperature within these limits. Wash the material into a 2-liter beaker or Erlenmeyer flask, dilute to a 3% acid concentration with 1500 ml. of distilled water, and boil for 4 hr., under either a reflux condenser or a nearly constant volume condition by the occasional addition of hot water to the flask.

After allowing the insoluble material to settle, filter into a filtering crucible which has previously been dried at 100 to 105°C. and weighed in a glass-stoppered weighing bottle. Wash the residue free of acid with 500 ml. of hot water, dry the crucible and contents in an oven for 2 hr. at 100 to 105°C., place in the weighing bottle, cool in a desiccator, loosen the stopper of the bottle, and weigh as lignin. Repeat the drying and weighing until the weight is constant.

Note: The lignin precipitate is sometimes very difficult to filter. If it is allowed to settle, the supernatant liquid can be decanted rapidly into the crucible. To facilitate this, the apparatus shown in Fig. 1 will be helpful in many cases. The full 500 ml. of wash water need not then be used; the washing may be terminated when the filtrate comes through free of acid.

REPORT

The weight of acid-insoluble lignin shall be reported as a percentage by weight of the moisture-free pulp.

REFERENCES

Bray, N. W., *Paper Trade J.* 87, No. 25: 59 (Dec. 20, 1928).
Ritter, G. J., Seborg, R. M., and Mitchell, R. L., *Ind. Eng. Chem., Anal. Ed.* 4: 202 (1932).

Water Vapor Permeability of Sheet Materials at 0°F.*

TAPPI Tentative Standard T 482 m-52

THIS STANDARD IS UNDER THE JURISDICTION OF THE PACKAGING MATERIALS TESTING COMMITTEE

This method is for the determination of water vapor permeability of paper, paperboard, and flexible packaging materials under storage conditions at 0°F. It is generally suitable for sheet materials up to 5 mils thick. The method has been developed because of increased emphasis on frozen-food production, and because no existing procedure gives results which correlate with those at 0°F. (TAPPI Standard T 448 m is suitable at temperatures of 73°F. and 50% relative humidity, and TAPPI Standard T 464 m applies at 100°F. and 90% R.H.)

In general, packaging materials used for storage at 0°F. should be capable of protection against an appreciable loss of moisture for periods up to 1 or 2 years. The final selection of materials for such storage is probably best done by actual package storage tests for the full length of time required. This method is a simplified and rapid method which has been shown to give results indicative of behavior during long-term storage. Many of the packaging materials are based on cellulose, including paper, paperboard, cellophane, and glassine. The time required for these materials to reach moisture equilibrium when exposed at 0°F. may be several weeks or months. The assumption is made in this procedure that equilibrium is reached, for practical purposes, in the 7-day initial conditioning period.

The rate of water vapor permeability of a sheet at 0°F. is the weight of water vapor transmitted per unit of area per unit of time under constant conditions of water vapor pressure differential. In this procedure, this is reported as grams of water per square meter per 24 hr. at 0°F., and at a relative humidity in equilibrium with cracked ice on one side of the membrane and a relative humidity in equilibrium with calcium chloride on the other.

APPARATUS

1. *Inner Box.* A heavy-walled (not less than 14-gage), sealed metal box in which the test dishes are placed, in groups four high, with at least a 1-in. clearance between the top of one specimen and the bottom of the test dish above, and with approximately 2-in. spacing between the top and bottom samples and the

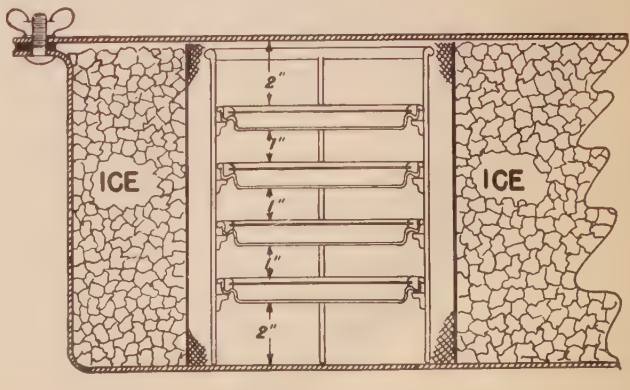

Fig. 1. Side view

* This method has been approved as a tentative standard by the Standards Committee. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

box. The metal box may hold any number of such units, with each rack of four surrounded on the sides by coarsely cracked ice. This is best done by use of $^1/_4$-in. mesh screen surrounding the racks holding the specimen. The tightly sealed box will minimize the temperature variation from the outside storage cabinet by reducing convection currents, and the ice will provide essentially saturated air at 0°F. The inner box is shown in Figs. 1 and 2.

2. *Outer Cabinet.* A refrigerated closet, commercial frozen-food storage cabinet, or household zero-storage unit. The temperature shall be held at zero ±3°F. The inner box shall be placed about 2 in. from the walls of the cabinet and floor, resting on wood or other insulating support.

3. *Test Dishes.* Open-mouth round dishes, made of aluminum, which after being closed by the specimen shall permit exposing an area of the specimen of 20.63 sq. in. (equivalent to a circle $5^1/_8$ in. in diameter), and of such design as to allow the specimen to be firmly sealed in position with wax without danger of vapor leakage or edge migration. A suitable design is shown in Fig. 3. They should be numbered or lettered to permit identification during the test.

4. *Metal Template.* For use in defining the test area and effecting the wax seal, consisting of a circular metal disk $5^1/_4$ in. in diameter on the upper surface, tapering to a $5^1/_8$ in. diameter on the lower surface, with a thickness at the edges of $^5/_{16}$ in.

The thickness at the center of the template should be $^1/_4$ in. greater than at the edges. With flexible materials, this allows for the shrinkage of the specimen, and prevents undue tension on the wax, which may affect the test. With rigid specimens, this tapered template is not as important.

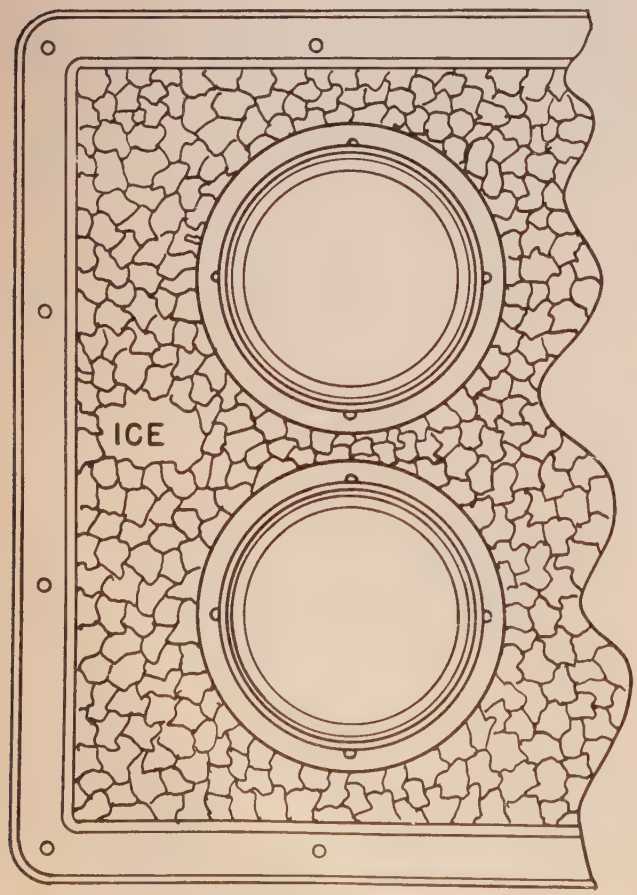

Fig. 2. Top view

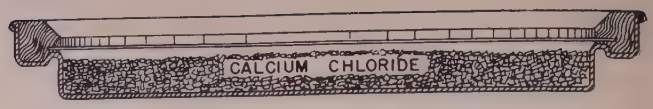

Fig. 3. Cross-section view

The upper surface of the template shall be provided with three or four metal lugs, to locate its surface concentrically with the inside peripheral edge of the plate. The lugs also provide support for the point of a lever which is applied to lift the template after the wax hardens. A small hole through the center of the template to admit air to its underside will facilitate its removal after the wax solidifies.

5. *Die Cutting Tool.* $5^5/_8$ in. in diameter, for cutting specimens to the required size.

6. *Analytical Balance.* 200-gram capacity, sensitive to 0.0005 gram, with pans large enough to hold the test dishes, which may be placed on edge for weighing.

7. *Desiccator.* Consisting of a standard 6-in. desiccator bottom and a 17-in. high bell jar for cover. A special metal box can also be used. A metal frame shall fit into the desiccator, holding 12 aluminum dishes. Anhydrous calcium chloride ($CaCl_2$) shall be used both at the top and bottom of the desiccator assembly. (Water vapor, being lighter than air, rises to the top so that desiccant is necessary there as well as the bottom.) The $CaCl_2$ shall be renewed after each two weeks of use, or more frequently if necessary.

8. *Soldering Iron.* Or other suitable device, with a hot point.

9. *Screen.* Forty-mesh, for straining impurities from the wax.

10. *Screwdriver.*

11. *Wax Melting Pot,* with thermometer.

12. *Sharp Knife.*

MATERIALS

A. *Desiccant.* Calcium chloride (anhydrous), 8-mesh.

B. *Wax.* For sealing the specimen to the test dish. The wax should cling tenaciously to the surfaces, and must not be brittle at 0°F. It must not check, crack, or release from the metal cup in going through the temperature cycle from room temperature to zero to room temperature. Any wax mixture or formulation which has the proper tack, stability, and tensile strength can be used. A satisfactory wax is Quaker State Cream Amo wax, melting point 130°F., obtainable from Quaker State Oil Refining Corp., Oil City, Pa. (Many other waxes and wax mixtures have been tested without success.)

C. *Mold-Release Compound.* One of the silicone mold-release compounds manufactured by Dow Corning (DC-4 or DC-7) will allow release of the template from the wax after pouring. Prior to use, remove all traces of wax from the template by cleaning and polishing, then warm and apply a thin continuous film of the compound.

TEST SPECIMEN

Test specimens shall be representative of the material being tested. Inspect each specimen for flaws, pin-

holes, and other defects that are not normal to the material, and select representative sections each about 6 in. square. Conduct the test in duplicate, or with additional test samples as necessary.

A suitable code designation should be used to distinguish between the two sides of the material, such as side 1 or side 2; or when there is an obvious difference between the two sides, such as side 1 waxed, and side 2 unwaxed. The different exposures during test may include:

(1) Flat samples with side 1 (usually the treated or coated side) exposed to the higher humidity.

(2) Flat samples with side 2 exposed to the higher humidity.

(3) Creased samples exposed as (1) and (2). (*See* TAPPI Standard T 465 m.) The preferred position is generally that corresponding to the actual product packaging. The low humidity ($CaCl_2$) atmosphere acts as an accentuated freezer storage space, and the cracked ice (high humidity) simulates the product packaged.

A thin, porous, strong tissue may be used under the specimen to prevent scratching by the $CaCl_2$.

PROCEDURE

Coat the template with a film of mold-release compound along the outer surface which contacts the wax. Pour 50 ml. of anhydrous $CaCl_2$ granules into each test dish and spread evenly over the bottom. Keep the dishes at room temperature. Place the specimen sheet in position, center the template, and allow it to come gently into contact with the specimen.

It is desirable to have the whole assembly at this stage on a small turntable arrangement so that the liquid wax can be poured continuously along the entire circumference of the trough. The assembly is not moved again until the wax congeals. At the proper temperature, the wax should flow readily around the template and appear to "wet" the aluminum. There must be no sign of wax chilling, which can be detected by a narrow crevice at the interface, rather than the concave meniscus indicating wetted contact.

The wax is preferably poured in two stages: (1) pour the wax at a temperature of about 175°F. into the annular space between the template and the rim of the aluminum dish to just cover the specimen. Cool the dish assemblies to about 40°F., after the wax has reached room temperature. This chilling minimizes trapped air volume contraction and resultant stress on the seal. (2) Pour the second increment of wax at 175°F., filling to within $^1/_{16}$ in. of the top of the dish. Cool the entire assembly to room temperature.

Remove the template by prying off with a screwdriver. Lift the template off the plate, which should come easily away without causing any injury to the membrane or to the seal (*see* Fig. 3). After the template has been removed, examine the prepared assembly for flaws. If there is any sign of fracture or parting of the wax seal from the edge of the pressed dish, apply sufficient heat along the outside edge with the soldering iron to melt the wax and repair the seal.

Record the dish code markings and place them in the racks of the inner box, face up, so that the $CaCl_2$ is not in contact with the specimen. Place the box in the outer cabinet and leave it there for 7 days to bring to equilibrium with the humidity and temperature. At the end of the 7 days, remove the test dishes from the inner box and place them in the glass desiccator without taking them from the zero atmosphere. It is necessary that the chilled specimens be rapidly transferred to the desiccator, since at this point moisture condensation must be avoided as far as possible. Transfer the desiccator to room temperature. Leave the samples in the desiccator until they have come to room temperature, and any possible surface moisture acquired during the transfer has been completely evaporated. Weigh each assembly to 0.001 gram at half-hour intervals until the weight is constant.

Return the test dishes to the inner box at 0°F., and hold for 28 days. At the end of this time, remove the samples from the box, transfer to the desiccator as before and reweigh. After weighing, inspect the specimen assemblies carefully for signs of failure at the wax seals, or any other defect which would warrant rejection.

The test dishes may be prepared for reuse by removing the specimen from the dish by heating for a short time on a hot plate in order to melt the wax. Discard the $CaCl_2$ and wash the dish with water and then with solvent to remove all wax.

REPORT

Report the water vapor permeability to three significant figures as grams per square meter (1550 sq. in.) per 24 hr. at 0°F., and for the humidity gradient defined.

The water vapor permeability is equal to the gain in weight of the dish in 28 days, expressed in grams, times the factor 2.68. The factor is obtained as follows:

$$\frac{1550 \text{ sq. in.} \times 24 \text{ hr.}}{20.63 \text{ sq. in. (area of specimen)} \times 28 \text{ days} \times 24 \text{ hr.}} = 2.68$$

PRECISION

Duplicate determinations should check within 10%, depending largely on the variation in the sheet material itself. The agreement between laboratories should be within 25%. This should establish any given sheet material quite definitely in the scale of permeabilities normally encountered in protective packaging at 0°F.

ADDITIONAL INFORMATION

This method is the result of work by the joint TAPPI-Packaging Institute Packaging Materials Testing Committee designed to improve the procedure, establish a suitable wax, and determine the degree of precision which may be expected within a laboratory, and between the six to eight laboratories cooperating in the work.

REFERENCE

Southwick, C. A., Jr., Proposed Packaging Institute Standard Test Method. "Water Vapor Permeability at Zero Fahrenheit," *Modern Packaging* 19, No. 11: 140–2, 172 (July, 1946).

38th Annual Meeting

Technical Association of the Pulp and Paper Industry

Hotel Commodore
Feb. 16–19, 1953

LETTERS TO THE EDITOR

Coal and Ash Handling

Ed. Note: In *Tappi* 35, no. 9: 40A–56A (September, 1952) an article was published on "Coal and Ash Handling," by Donald M. Given, Jr., and Carl A. Marshall of the Fairmount Coal Bureau. Following are two responses to inquiries regarding this article by Mr. Given:

To the Editor, *Tappi:*

As requested in your letter of October 7, the address of National Conveyor & Supply Co. is 350 North Harding Ave., Chicago 24, Ill. To our knowledge, this is the only car shaker on the market which costs less than $12,000 or $15,000 installed.

We know of a number of plants where it is being used very satisfactorily. Like all shakers, it does not supplant the need for first thawing frozen car hoppers.

To the Editor, *Tappi:*

As requested in your letter of October 7, the portable car-thawing equipment is manufactured by Hauck Mfg. Co., 109 Tenth St., Brooklyn 15, N. Y. They also make thawing pits.

We were pleased to hear that your pulp and paper Material Handling Committee plans to thoroughly investigate unloading frozen coal from railroad cars. We should be most interested in receiving a copy of your findings when they become available.

Our own thoughts on the matter are that steam hoses are effective but dangerous and unsatisfactory because of the moisture added to the coal. Oil treatment of the coal is not effective freezeproofing but is primarily a dustproofing measure. Calcium chloride is effective but extremely corrosive to conveyors and bunkers. Many of the public-utility plants install Hauck thawing pits under the track with a wind shield on either side of the track. A corrugated iron sheet about six feet high makes an effective wind shield.

You might also be interested in the enclosed copy of our latest article on handling coal and ashes, which introduces a few ideas on flow restrictions and size segregation in coal-handling systems, both of which problems have been much neglected in the past.

Sulphite Digester Inspection

Ed. Note: The following exchange of correspondence is published for its information value. Since neither the inquirer nor the respondents have given permission to reveal their identities, their names will be omitted:

To the Editor, *Tappi:*

I wonder if you could help me with a problem which we have run into with our Authorities here in connection with the inspection of sulphite digesters.

Our digesters are lined with acidproof material to the following specifications:

1. An outer lining 1 in. thick next to the steel plates of the digester shell, consisting of a special acid-resisting pitch cement. This cement has been developed over a number of years and has been used successfully for many years.
2. A second lining approximately 3 inches thick consisting of refractory tiles bedded into and jointed with an acid-resisting cement.
3. A third lining of special thermoplastic approximately $1/2$ in. to $3/4$ in. thick, which when "cured" at a temperature of 230°F., hardens to a monolithic lining which is impervious to acid.
4. An inner lining consisting of "Carblox" (carbon) tiles embedded into a special "mortar," which, when brought up to a temperature of 230°F., fuses to the carbon tiles and the thermoplastic of the third lining. These tiles are specially shaped to join closely to the adjacent tiles with the minumum thickness of jointing "mortar" and on completion present a smooth spherical surface inside the digester.
5. After the various linings of the "Carblox" tiles have been installed, the digester is charged with steam and maintained at a temperature of 230°F. for 24 hr to "cure" the thermoplastic materials used in linings 3 and 4, before the digester is put into commercial service.

Normal routine inspections of these linings have shown that after a period of 26 months they are free of defect and show no evidence of weakness whatsoever. The factory inspector is, however, insisting that a part of this lining should be removed in order to inspect the actual steel shell of the boiler.

As you will realize, such removal of a part of the lining would, when the part is replaced, make the lining much more vulnerable to acid leakage at the joints and indeed we feel that this would destroy the resistance of the lining to leakage and would be a source of danger.

I believe that a similar type of lining is used in the States and we have suggested to the Factory Inspector that adequate inspection of the metal shell can be made by using ultrasonic test equipment as we have found that by this means plate thickness variations within 1% can be detected and I am wondering whether such methods of testing are used and approved by the Authorities in America.

I feel that if we can refer to similar equipment being used in other countries it would help us in our discussions with our Factory Inspector and any information you can give me on this subject would be very much appreciated.

To the Editor, *Tappi:*

First, the inquirer is correct in his viewpoint as concerns inspection of the protective efficiency of a lining through removal of a patch. It would be a pure matter of chance that removing a patch from a lining would uncover a spot or zone that might be suffering corrosion. The reinstallation of the patch after the inspection would be difficult in the direction of assuring that an opportunity for leakage at the patch joints is not created. The only way that a positive inspection can be made of the shell by this approach is the complete removal of the lining. To me, such a procedure would be foolish after only two or three years' service.

I am not sure that other methods of shell inspection, such as one using an ultrasonic device or a Beta-ray gage, are recognized by insurance inspectors as being adequate. However, I do know that a Beta-ray gage inspection was made of the digester at the Anglo-Newfoundland plant. Subsequent to this inspection the linings were removed because of serious failure and the visual inspection of the shell checked exactly the findings that were developed through the use of the Beta-ray gage. I suggest that you contact the Pulp & Paper Institute of Canada relative to this particular technique, since they have used it in our mill at Terrace Bay and subsequently arranged for the services at Anglo-Newfoundland already mentioned.

To the Editor, *Tappi:*

It is our practice in the inspection of sulphite digesters in this country to instruct the superintendent to be on the lookout for wet spots each time the digester is blown. If there is any defect in the lining and the liquor seeps in behind when the digester is blown down to atmospheric pressure, the liquor will "blow back" from the lining leaving a very noticeable wet spot. If this is found, we then recommend that the lining be removed from the defective area so that the extent of any corrosion may be determined.

Tell-tale holes in the shell are frequently used to reveal any area where liquor might be leaking behind the lining. If the

lining is in good condition as determined by careful visual inspection, we do not recommend that it be disturbed.

We use the Audigage here periodically to check the thickness of digester shells, particularly if there is any suspicion that corrosion or wasting has taken place.

Out of the 205 digesters that we insure and inspect, we have checked with the Audigage or by drill testing the thickness of all but 23 of these digesters this year.

We have had a very good success with the Audigage and in fact have just purchased a second unit. We find that it is accurate to within 3%. It is very easy to use and not difficult to train personnel to take accurate readings.

The above inspection program is carried out in Code states where digesters come within the scope of pressure-vessel inspection regulations.

To the Editor, *Tappi:*

Herein is a description of practice as it is followed in the sulphite mills and kraft mills of this area (West Coast).

First, a description of the lining. Most sulphite digesters are of the stationary type, vertical. The steel shell is riveted with inner and outer butt straps. A shell course of the brick lining is spaced inside the shell to clear the butt straps, and the space filled with a poured grout of Portland cement, silica sand, and sufficient water to make fluid. The pour is made in relatively short lifts to avoid excessive fluid pressure on the brick. At this mill the grout is $1^1/_2$ in. average thickness except at butt straps.

Shell course of brick is shaped digester lining brick of 2-in. thickness which is layed with cement of glycerin and 20% litharge.

Between shell course of brick and inner or face course is a space of 1 in., filled with grout as above.

The face course is a 3-in. shaped digester brick. For calcium base cooking acid this is layed in 35% litharge and glycerin. Other material is used for pointing digesters which are cooking with magnesia or ammonia base cooking acid.

Secondly, what methods are employed for inspection? Of primary importance is the inspection which takes place at the end of each cook. This is made by the operating crew, who look for evidence of spalled brick and for the wet spot which would show that during the time a digester was under pressure, acid had gone through an opening into the grout, and upon release of pressure was leaking back into the digester. Any unusual sight is reported to the shift superintendent, who inspects before the digester is filled. If the shift superintendent believes that repair work may be necessary, those responsible for such work are informed.

The exteriors of digesters are subjected to frequent inspection by operating and maintenance personnel. Any leakage of sulphur dioxide is investigated, and if it is found to be due to a leak through the lining and out through a shell opening such as a rivet or strainer bolt the digester is removed from service until repair can be made.

Under state law, pressure vessels must be periodically inspected by the Washington State Chief Boiler Inspector or his deputy. The inspectors of insurance companies carrying the risk are deputized to make the official inspection, and do so at regular intervals. They inspect digester exteriors while operating under pressure. At holiday shutdowns they inspect the digester interiors. If at any time there has been leakage which has contacted the shell, a special inspection is made at the request of the mill to the insurance company.

At this point it should be emphasized that the shell interior surface is uncovered for inspection only when there has been an occurrence of leakage known to have contacted the shell, or when suspected to have passed beyond the barrier imposed by the shell course. The inspectors realize that unless there is a flow of acid: (a) past the shell and out of the digester; or (b) into a cavity next to the shell and back into digester repeating at each cycle of cooking, there is no danger of damaging corrosion.

Even when a digester is to have its face lining renewed, there is usually no demand for inspection of the shell of the digester. In this respect the interests of the insurers and management coincide in wishing to get into any doubtful locality and be sure that no damage has been done to the pressure vessel.

Consider now the utility of sonic inspection. An instrument known as the Audigage is employed in the kraft mills to make routine inspection of the digester shells and record the thickness of steel plate. This has been checked in some mills by test drilling and record of such checks has been published. The instrument produces readings to the nearest hundredth of an inch. Such a record on the writer's desk has several readings in three decimals—1.525-in. for instance meaning that the thickness is greater than 1.52-in. but not as much as 1.53-in.

Not only does the Audigage show variation in plate thickness at various places on the digesters, it also shows the progressive thinning of the plate from measurement to measurement (at the same point of the shell) with such accuracy that it is possible to plot corrosion rate in fractions of an inch per year and to determine which areas have the least and most corrosion.

At the Weyerhaeuser mill at Springfield, Ore., it was recently reported at an engineering conference that over a period of 3.2 years the corrosion in an area of severe attack has been 0.146-in. per year, determined by Audigage. I do not doubt that the suppliers of this equipment could amplify considerably upon this report, and could also show an inspector that the readings were valid by making tests upon plates of various known thickness.

One further remark in regard to the inquirer's trouble. At times the inspectors have requested drilling of the steel shell with a small hole which can be tapped and plugged. This can be used to check plate thickness, and also, by removal of plug, would serve as a check point for detection of liquid next to the shell. This method is not regarded with much favor by those inspectors experienced in field work, who have observed the very devious path which is sometimes followed by an acid leak. Freedom from wet spots immediately after a pressure cycle is the best condition. Check with an Audigage will show metal thickness.

To the Editor, *Tappi:*

It is a coincidence that just yesterday evening I ran across an article in the October issue of *Plant Engineering* which contained a reference to the problem that confronts you, and today receive your letter of the tenth of October. The article refers to digesters at the Angle-Canadian Pulp & Paper Mills, Quebec, P. Q., Canada, which were known to have areas of corrosion. The mill did not want to remove the entire lining. According to the article, the shell was mapped with a "gammagage" which revealed the precise location of corrosion and thereby reduced the area which was opened for repair.

I have written the publishers of this magazine, requesting that they forward tear sheets of this article to you. It may be additional material in your discussion with the pressure vessel inspectors.

To the Editor, *Tappi:*

All replies commenting on the content of this letter were unanimous in opinion "that portions of the lining should not be removed for an inspection."

Inspections of this sort should be made when and if brick linings are being removed from the whole digester by reason of evident need for replacement.

Committee members can suggest the use of the following devices which have been tried under somewhat different conditions than the condition described at St. Cuthbert's Paper Works:

1. Audigage.
2. Beta-ray thickness gage.

3. Radioactive source in center of digester and photograph around exterior.

If bleeder taps have been in place on the inquirer's digester for several years and if during that time there has been no substantial amount of drip from these taps it seems to me that the steel shell probably has not been weakened enough to cause probable failure.

To the Editor, *Tappi:*

Your letter of September 11 addressed to R. G. Macdonald has been passed on to us, and we will attempt to answer your questions.

It is very interesting to note the method you use in installing a digester lining. It is entirely different from the method used in this country, and the cost would be prohibitive.

At the present time we are lining digesters using a single course of 3-in. brick and laying it up in a furfural-resin cement or a litharge composition joint material. After the joint has set up we pour grout, consisting of Portland cement and digested quartz in between the back of the brick and the steel shell. This grout thickness is anywhere from $2^1/_2$ in. to 3 in. thick, making the total thickness of the single course lining $5^1/_2$ to 6 in.

We also make double laid lining installations using a 2-in., very dense brick in the backing, which can be laid up in either litharge composition joint material or furfural joint material. Grout is poured in back of the backing brick, making the total thickness of the backing $3^1/_4$ in. On smaller digesters we are using thinner backing brick so as to cut down on the thickness of the lining. The face course brick, which is 3 in. thick and is not too hard to burn, is laid up in furfural resin cement. The backs of the brick are buttered with this joint material and the brick embedded in the backing, making the total thickness of the face course $3^1/_4$ in. This type of lining is used throughout this country for soluble base cooking.

Another type of double laid lining is that the backing brick is laid up in a litharge composition cement, and the face course is laid up in a litharge composition cement and grout is poured between the two courses of brick. This type of lining is $7^1/_2$ in. thick.

During inspection of the linings the inspector looks the linings over and if the digester lining has excessive spalling he can measure this spalling by drilling a hold in the brick at the deepest spall. If the face course brick gets so that it is about 1 in. or $1^1/_2$ in. in thickness he gets rather concerned over the lining, but a considerable amount of judgment is left up to the operators on the replacement of the linings, and when a lining gets down to a thickness of 1 in. or $1^1/_4$ in., they usually proceed to replace that lining.

If a double laid lining is in the digester, the insurance inspector may be called in to inspect the backing brick, and the steel shell on the outside. Very seldom does he require the backing brick, to be cut out to the steel shell. The backing brick may be in the digester 20 to 25 years during which time the inspector never sees the steel shell.

A leak in the lining is very noticeable right directly after the digester blows. If the digester isn't perfectly tight there will be a kickback, and unless this kickback is pumped with silicate of soda the acid may work its way to the steel shell and cause considerable damage. There must be a series of kickbacks in the lining which are serious, before the inspector will demand to see the steel shell to see how much damage has been caused by the leaking lining.

We note in your letter that routine inspections are made of your linings, and after a period of 26 months they are free of defects. If the lining is perfectly dry after blowing it is a rather foolish move to cut part of the lining out so that the steel can be seen. This is just inviting trouble.

We know that tests are being made by ultrasonic test equipment on sulphate digesters, and possibly they were made on the sulphite digesters in British Columbia, where they had so much trouble with welded shells. We did not install those linings, and we do not have a complete story on the difficulties experienced.

We would say that a dry lining after a blow is the best indication that you have a satisfactory lining and that the acid is not affecting the steel whatsoever.

EMPLOYMENT SERVICE

Positions Wanted

E196-52. Experienced Chemist. Many years' research and development experience in papermaking and coating. Experienced also in sales and sales service to the paper industry. Desires position with paper manufacturer in development of improved papers. Will consider employment by chemical manufacturer in sales to the paper industry.

E204-52. Paper Mill Superintendent now available. Capable of handling Yankee or regular fourdrinier machines in the manufacture of facials, toilet or lightweight kraft, and sulphite specialties.

E205-52. Graduate Paper Chemist. 16 years' diversified experience in research, development and control includes fields of coarse papers, board, and semichemical pulp. Seeking stable connection as Technical Assistant to Mill Manager or Technical Director.

E206-52. Experienced Chemical Engineer. Many years in research and development on specialty board and wet machine products. Much experience in the graphic arts field. Desires laboratory position requiring imagination.

E207-52. Superintendent-Chemist. Practical and technical experience in diversified fourdrinier mills. Desires supervisory or assistant's position with a progressive firm.

Positions Open

P243-52. Association Staff Engineer. 30–40 years. Duties include technical correspondence covering all aspects of pulp and paper technology; coordination and promotion of Association committee activities; preparation and editing of special reports and monographs, standard testing methods, technical data sheets; and participation in various Association activities.

P245-52. Research Director. An old established concern located in the Middle West manufacturing specialty papers has an opening for a man with a thorough background in paper research. Man applying must have real research ability rather than laboratory technician experience.

P252-52. Sales Engineer. Outstanding opportunity in capital equipment sales—heavy industrial process measuring and control equipment—for a graduate with five plus years of successful capital equipment sales experience and a thorough knowledge of sheet process manufacturing equipment in the paper, rubber, or plastics industry. Our organization is the recognized leader in the development and manufacture of industrial uses of nucleus energy and our continuous expansion offers unparalleled opportunity for a sales engineer capable of working with the executive echelon. Duties include the direction of supporting application engineers. Qualified applicants are requested to submit a complete résumé of education and experience to Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio.

P253-52. Chemist or Chemical Engineer wanted for sales and service work by company manufacturing and selling adhesives for paper coating and paper converting operations.

P254-52. Mechanical Engineer for medium-size modern integrated paper mill in New York State. Good opportunities. Housing available. Experience desired but not essential. Contact Personnel Department, Gould Paper Co., Lyons Falls, N. Y.

PAPER TECHNOLOGIST

Wanted, a young man with ambition, personality, and potentiality for advancement, to carry out laboratory and field application research on chemicals for the paper industry. An attractive opening in the Research and Development Department of a New England chemical manufacturer, supplying diversified requirements to the paper trade, will be filled by a B.S. or M.S. Chemist or Chemical Engineer, preferably educated in paper technology, and with at least two years' practical experience in paper making, finishing or converting. Applicants should submit a confidential statement of qualifications, experience and salary requirements to *Tappi*, P-255-52, 122 E. 42nd St., New York 17, N. Y.

UNITED STATES PATENTS ON PAPERMAKING

Third Quarter, 1952

Compiled by CLARENCE J. WEST

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture.

Copies of any of the following patents can be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

July 1, 1952

2,601,750. Carton handling and loading apparatus. Richard J. Fahey and Martin Burger, assignors to Shellmar Products Corp., Chicago, Ill. Filed Nov. 23, 1946. 20 claims. (Cl. 53-16.) An automatic positioning of egg cartons in side-by-side arrangement prior to filling.

2,601,814. Jordan plug jacket. Oscar E. Larson, assignor to John W. Bolton & Sons, Inc., Lawrence, Mass. Filed Jan. 23, 1946. 11 claims. (Cl. 92-27.) A jordan shell construction embodies a series of disks with cut-out portions which are adapted to receive the knives.

2,601,815. Die for molding pulp articles. William J. De Reamer, assignor to Mapes Consolidated Manufacturing Co., Griffith, Ind. Filed Dec. 14, 1945. 11 claims. (Cl. 92-54.) A die for molding pulp articles includes a sheetlike body with closely arranged, relatively deep depressions and high projections.

2,601,816. Machine for inserting handles in cartons. Lawrence E. Arneson, assignor to Morris Paper Mills, Chicago, Ill. Filed June 2, 1947. 12 claims. (Cl. 93-36.7.) A machine is provided for the insertion of U- or C-shaped metal carrying handles into cardboard bottle carriers.

2,601,945. Container with water shedding top construction. Carl G. Preis, assignor to American Can Co., New York, N. Y. Filed April 14, 1949. 4 claims. (Cl. 229-7.) A paperboard milk container is provided with a domed top member.

2,601,946. Dry or pressure-sealing envelope. Vincent E. Heywood, assignor to United States Envelope Co., Springfield, Mass. Filed Nov. 24, 1948. 17 claims. (Cl. 229-80.) The envelope is provided with a pull tap for opening its sealed closure flap, which is coated with a layer of tacky rubber latex.

2,601,957. Congrot system for matching the speeds of mills and reels. Allan C. Halter, assignor to Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Filed Nov. 5, 1949. 5 claims. (Cl. 242-75.) A system is provided for controlling the speed of a reel during the threading of a strip in which variations in the tension setting of the strip during winding are ineffective to vary the speed of the reel during threading.

2,602,029. Manufacture of bituminized fibrous products. Leonard C. Bradshaw, assignor to International Bitumen Emulsions Ltd., Slough, England. Filed Sept. 17, 1946. 6 claims. (Cl. 92-21.) A sheet is formed from approximately equal parts of asbestos fibers and a binder of fatty acid pitch mixed with sufficient sulphur to accelerate hardening and modified with a hard bitumen.

2,602,035. Paper pulp coating of coils. Guglielmo Camilli, Willard F. M. Gray, and Leo Mulligan, assignors to General Electric Co., Schenectady, N. Y. Filed Sept. 8, 1949. 2 claims. (Cl. 154-80.) A method for the hydraulic application of paper pulp insulation to electrical coils.

2,602,071. Copolymerization of vinyl monomers with fatty oils, fatty acids, resins, and the like. Edward C. Haines, assignor to Geo. D. Wetherill Varnish Co., Inc., Camden, N. J. Filed March 23, 1949. 7 claims. (Cl. 260-23.) The copolymerization of styrene and tall oil gives a product suitable for paints and varnishes.

2,602,089. Process of preparing guaiacyl compounds from lignin. Irwin A. Pearl, assignor to Sulphite Products Corp., Appleton, Wis. Filed Nov. 12, 1949. 6 claims. (Cl. 260-521.) Lignin (e.g., from sugar-free fermented spent sulphite liquor) is oxidized with cupric oxide and excess sodium hydroxide under pressure at 160–180°C.

July 8, 1952

2,602,325. Pulp testing device, John F. Campbell and Theodore M. Shirley, assignors to The Patent and Licensing Corp., New York, N. Y. Filed Dec. 31, 1947. 2 claims. (Cl. 73-63.) A freeness tester is designed for the measurement of the drainage characteristics of wood-fiber insulating-board pulps.

2,602,379. Beater. George W. Dodge, assignor to The Noble & Wood Machine Co., Hoosick Falls, N. Y. Filed Oct. 9, 1945. 1 claim. (Cl. 92-22.) A beater is designed so that runs can be made under controlled conditions of temperature, hydraulic shear, consistency, and pressure.

2,602,380. Cylinder-tissue paper machine. Estel B. Geary, Niles, Mich. Filed June 20, 1950. 2 claims. (Cl. 92-43.) The machine is so constructed that excessive pressure on the paper web is eliminated and no pressure is required on the drier felt.

2,602,381. Liquid-removing pressure roller. Waldemar C. Ewaldson, assignor to Western Electric Co., Inc., New York, N. Y. Filed April 16, 1947. 3 claims. (Cl. 92–49.) The pressure rollers of a pulp-insulating machine include a drive roller which rotates about a fixed axis and has annular grooves in its periphery adapted to receive ribbons of pulp surrounding electrical conductors.

2,602,382. Machine for making laminated paper tubes. Rudolph H. von Liedtke, Chicago, Ill., assignor to McGraw Electric Co. Filed Sept. 4, 1945. 1 claim. (Cl. 92-66.) A machine for the manufacture of laminated tubes from paper pulp.

2,602,383. Method of making paper containers. Cesare Barbiere, assignor to Dixie Cup Co., Chicago, Ill. Filed Jan. 10, 1948. 2 claims. (Cl. 93-39.1.) A paper cup is designed for hot liquids.

2,602,416. Apparatus for treating box blanks. Louis Perilli, Waltham, Mass. Filed Dec. 11, 1950. 16 claims. (Cl. 118-101.) An apparatus is provided for the removal of wax coatings from certain areas of precoated paper box blanks by the application of heat.

2,602,559. Venting closure and liner therefor. Edward L. Dryer, assignor to Armstrong Cork Co., Lancaster, Pa. Filed Sept. 24, 1948. 2 claims. (Cl. 215-56.) A closure cap for bottles of bleaching solution embodies a composite liner which is capable of venting excess pressure developed in the bottles.

2,602,581. Carton. William T. Stearn, assignor, to Celanese Corp. of America, New York, N. Y. Filed Oct. 21, 1948. 2 claims. (Cl. 229-45.) A corrugated board shipping carton is adapted for the packaging of cones of yarn.

2,602,739. Sizing compositions and their preparation and use in paper. Harco J. Tadema, assignor to Shell Development Co., San Francisco, Calif. Filed July 28, 1947. 9 claims. (Cl. 92-21.) A paper sizing agent consists of an aqueous emulsion of rosin and an Edeleanu extract of lubricating oil.

July 15, 1952

2,603,083. Apparatus for testing the resistance of materials to abrasion. Herbert F. Schiefer, assignor to the United States of America as represented by the Secretary of Commerce. Filed Feb. 19, 1948. 5 claims. (Cl. 73-7.) The tester embodies a belt-driven abradant wheel and a sample-holding ring which are rotated in the same direction and with the same angular velocity but about different axes.

2,603,156. Shock-resistant product. Elbert C. Lathrop and Theodore R. Naffziger, assignors to the United States of America as represented by the Secretary of Agriculture. Filed Aug. 2, 1946. 11 claims. (Cl. 102-95.) A board formed of water-softened vegetable fibers (e.g., wheat straw) and beaten, chemically hydrated papermaking fibers is used for shotgun shell wads.

2,603,181. Machine for applying adhesive to carton flaps. John Van Buren, assignor to Chisholm-Ryder Co. of Pennsylvania, Hanover, Pa. Filed Dec. 4, 1948. 4 claims. (Cl. 118-253.) Measured amounts of glue are accurately applied to the parts of the carton to be sealed.

2,603,350. Carton for handled tools. Carl S. Lehman, assignor to The Fairfield Paper and Container Co., Baltimore, Ohio. Filed May 29, 1951. 5 claims. (Cl. 206-65.) The carton is so constructed that the tool heads (axes) cannot break or cut the carton.

2,306,364. Magazine feed. Ludwig K. Heinrich, assignor to Celotex Corp., Chicago, Ill. Filed Sept. 13, 1946. 2 claims. (Cl. 214-8.5.) A magazine-type sheet feeder is described in

which the sheets being fed are prevented from rocking back and forth while in the magazine.

2,603,380. Head and shell joint for drier drums. Lloyd Hornbostel, assignor to Beloit Iron Works, Beloit, Wis. Filed March 2, 1946. 6 claims. (Cl. 220-55.) A bridging clamp arrangement is provided for locking the heads of a drier drum to the shell without perforating the latter.

2,603,400. Container and closure. James A Hollinshead, assignor to Consolidated Paper Co., Monroe, Mich. Filed Oct. 4, 1948. 2 claims. (Cl. 229-5.5.) A hexagonal end closure for a cylindrical fiber drum consists of six symmetrical triangular scored portions.

2,603,401. Shipping containers. Herman H. Strauss, assignor to Gaylord Container Corp., St. Louis, Mo. Filed April 1, 1949. 2 claims. (Cl. 229-5.5.) The container is provided with side wall panel flaps which are designed to form triangular ledge sections.

2,603,402. Shipping container. Herman H. Strauss, assignor to Gaylord Container Corp., St. Louis, Mo. Filed March 5, 1951. 1 claim. (Cl. 229-5.5.) The container is provided with separate end closure disks which are retained by integral hollow ledge sections formed by inwardly folded marginal flaps of the side wall panels.

2,603,403. Consumer type container end structure. Glenn S. Thompson, assignor to Ira M. Jones, River Hills, Wis. Filed May 22, 1947. 10 claims. (Cl. 229-5.5.) A food container has hollow rims at both ends, which serve to reinforce the body and form supporting ledges for end closures.

2,603,404. Carton. Elmer E. Eldredge, assignor to Robert L. Eldredge, Plymouth, Wis. Filed Sept. 20, 1949. 1 claim. (Cl. 229-16.) A double-wall corrugated carton for cheese is reinforced at each of its four vertical edges.

2,603,405. Book style carton with infolded sides. William P. Frankenstein, Cincinnati, Ohio. Filed Feb. 14, 1945. 10 claims. (Cl. 229-31.) In a book-style carton the halves of the box are provided with hollow, spaced walls.

2,603,406. Corner construction for marginally flanged paperboard container covers, Walter C. George, assignor to Gaylord Container Corp., St. Louis, Mo. Filed Oct. 4, 1949. 7 claims. (Cl. 229-44.) The construction of the corner is described.

2,603,407. Handled container and method of manufacture, Jay D. Crary, assignor to Paper Strap Inc., Portland, Ore. Filed June 2, 1948. 15 claims. (Cl. 229-54.) A paper shopping bag is provided with a multi-ply paper-strap carrying handle.

2,603,408. Shopping bag. Jay D. Crary, assignor to Paper Strap Inc., Portland, Ore. Filed June 13, 1949. 3 claims. (Cl. 229-54.) The carrying strap has a relatively flat gripping surface.

2,603,409. Handled container. Jay D. Crary, assignor to Paper Strap Inc., Portland, Ore. Filed June 30, 1950. 6 claims. (Cl. 229-54.) A shopping bag with a carrying handle.

2,603,410. Mailing piece. James E. True and John B. Ruffalo, assignors to True Associates John Service Corp., New York, N. Y. Filed June 29, 1949. 1 claim. (Cl. 229-92.1.) A letter is provided with one or more pockets for enclosures.

2,603,571. Mastic floor covering and a process of making it. William Castellano, assignor to Union Oil Co. of California, Los Angeles, Calif. Filed Dec. 19, 1949. 17 claims. (Cl. 106-123.) The covering is formed from a mixed polyhydric alcohol ester of tall oil pitch and acids produced by the oxidation of paraffin wax; this is hardened by the addition of ethylcellulose.

2,603,575. Method of making stiffened permeable resin coated fibrous sheets. August F. Schramm, Jr., White Plains, N. Y. Filed Nov. 17, 1949. 3 claims. (Cl. 117-16.) Sulphite paper or thin felt is waterproofed by addition of a vinyl chloride-vinyl acetate copolymer and a phosphate plasticizer and heating the sheet.

2,603,611. Styrenated oil-tall oil vinyl esters coating compositions. Paul E. Marling, assignor to Monsanto Chemical Co., St. Louis, Mo. Filed Oct. 25, 1948. 10 claims. (Cl. 260-23.) A transparent coating composition resistant to thermal softening and the action of organic solvents and alkali comprises 10 to 75% of a mixture of the vinyl esters of tall oil acids and 25 to 90% of a copolymer of 40 to 60% of a fatty acid-containing natural drying oil and 40 to 60% of α-methylstyrene.

2,603,614. Flameproofing. Morris L. Nielsen and Howard K. Nason, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 30, 1949. 7 claims. (Cl. 260-30.2.) The product is a combination of a resorcinol- or phenol-formaldehyde resin and 3 to 90% of the reaction product of 2 to 4 moles of melamine and 1 mole of phosphorus pentoxide heated to about 400°C.

July 22, 1952

2,603,969. Art of evaluating sanitary paper products. John T. Sobota, assignor to Fort Howard Paper Co., Green Bay, Wis. Filed Oct. 5, 1949. 2 claims. (Cl. 73-159.) A portable apparatus is designed for demonstrating the absorbency of toilet tissue.

2,604,021. Supporting holder for container blanks. André Schick, Lausanne, Switzerland. Filed Aug. 2, 1950. 6 claims. (Cl. 93-49.) A supporting holder is used in the erection of cardboard bakery boxes from flat blanks.

2,604,022. Paper box folding and corner locking machine. Frank A. Bellato, assignor to Carando Machine Works, Stockton, Calif. Filed Feb. 23, 1951. 6 claims. (Cl. 93-51.) The machine incorporates fingers as part of a plunger and die assembly for engaging hook-and-eye connections between infolded tabs on the ends of a box.

2,604,067. Coating feed mechanism for gate rolls. Howard B. Richmond and Robert W. Mortensen, assignors to Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis. Filed Aug. 12, 1950. 10 claims. (Cl. 118-262.) The mechanism includes means for continuously carrying a coating material feed pipe back and forth along the entire length of the nip of the gate rolls.

2,064,252. Tight carton. Frank D. Bergstein, Cincinnati, Ohio. Filed April 9, 1947. 7 claims. (Cl. 229-5.5.) A thermoplastic composition is sprayed onto the inner surface of the end closure.

2,604,253. Bib dispensing carton. Georgia B. Turner, Oklahoma City, Okla. Filed July 11, 1949. 4 claims. (Cl. 229-7.)

2,604,254. Box or carton. Louis Rosenfield, assignor to Miro Container Co., Inc., Brooklyn, N. Y. Filed May 8, 1950. 1 claim. (Cl. 229-8.) A heart-shaped box is provided with stiff paper rims adhesively attached to the cover and base.

2,604,255. Golf club box. Charles D. Welshenbach, assignor to The Hinde & Dauch Paper Co., Sandusky, Ohio. Filed Feb. 12, 1949. 3 claims. (Cl. 229-27.) The container has separating partitions for spacing the ends of the clubs.

2,604,256. Protective device. Earl B. Whitehead, assignor to Atlantic Carton Corp., Norwich, Conn. Filed Sept. 13, 1950. 2 claims. (Cl. 229-89.) V-shaped tabs engage the inner walls of the carton and hold the articles away from the walls.

2,604,354. Bottle carrier. Harry Z. Gray, Lebanon, Ohio. Filed Sept. 11, 1948. 9 claims. (Cl. 294-87.2.) A two-layer flat sheet is formed with staggered openings in each layer and with bottle-engaging tabs.

2,604,421. Apparatus for manufacturing corrugated inserts, adapted to be used in boxes. Fritz Widmer and Hermann Elmiger, assignors to Packmat A.G., Olten, Switzerland. Filed Feb. 28, 1950. 7 claims. (Cl. 154-30.) A corrugated strip is formed to which a facing sheet is adhesively attached.

2,604,422. Metal joint for panels. James J. Plzak and Carl E. Husome, assignors to Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis. Filed Oct. 25, 1946. 5 claims. (Cl. 154-45.9.) A laminated paper or wood veneer panel incorporates a thin metal strip between adjacent subpanels to serve as a waterproof corner connector.

2,604,423. Cellophane laminated with styrene-isobutylene copolymer. Ober C. Slotterbeck, William H. Smyers, and David W. Young, assignors to Standard Oil Development Co., Linden, N. J. Filed Oct. 6, 1944. 4 claims. (Cl. 154-46.)

2,604,424. Glass fiber reinforced crepe paper. Kenneth N. Mathes, assignor to General Electric Co., Schenectady, N. Y. Filed Dec. 18, 1948. 1 claim. (Cl. 154-53.6.) Paper having lengthwise creping is coated on one side with glass fibers individually spaced in substantially parallel relation to the creping.

2,604,426. Method of fabricating a double-wall container. Emile McK. Beekman, assignor to the United States of America as represented by the Secretary of the Army. Filed Sept. 1, 1950. 4 claims. (Cl. 154-83.) A double-wall, molded, resin-impregnated paper container is adapted for the shipment of storage batteries.

July 29, 1952

2,604,783. Device for testing gummed tape. Paul W. Herrlinger, assignor to The Gummed Products Co., Troy, Ohio. Filed Jan. 27, 1950. 12 claims. (Cl. 73-150.) A device for measuring the wet tensile strength of gummed tape under conditions simulating actual use.

2,604,824. Jordan engine construction. Ralph L. Draper, assignor to John W. Bolton & Sons, Inc., Lawrence, Mass. Filed May 5, 1947. 4 claims. (Cl. 92-27.) A jordan plug is provided with multiple-part, keystone-shaped separating members for insertion between the knives.

2,604,825. Box blank taping machine. Karl Sieg, assignor to Samuel M. Langston Co., Camden, N. J. Filed April 7, 1948. 6 claims. (Cl. 93-36.9.) Machine for applying adhesive tape to a box blank formed of double-faced corrugated board.

2,604,826. Apparatus for making packages. Frank D. Palmer, assignor to Package Machinery Co., East Longmeadow, Mass. Filed May 31, 1944. 11 claims. (Cl. 93-39.2.) A machine for the manufacture of tubular containers for salt, sugar, and the like is described; they have a pouring spout which can be repeatedly opened and closed.

2,604,827. Carton erecting machine. Robert J. Hickin and Gerald H. Steele, assignors to The Ohio Boxboard Co., Rittman, Ohio. Filed April 17, 1950. 3 claims. (Cl. 93-51.) The ap-

paratus is designed particularly for cartons of the corner-lock tray type.

2,604,828. Boxmaking machine. Samuel W. Langdon, assignor of one half each to Harold J. Nagle and Reginald A. Nagle, Rochester, N. Y. Filed Jan. 22, 1949. 6 claims. (Cl. 93-54.2.) A machine for wrapping unstayed box blanks.

2,604,829. Drier mechanism for envelope machines. Vincent E. Heywood, assignor to United States Envelope Co., Springfield, Mass. Filed April 17, 1948. 12 claims. (Cl. 93-74.) A mechanism designed to dry the gummed portion of the seal flap before the envelopes are stacked together.

2,604,830. Method of winding composite tubular articles. Carl W. Heinle, assignor to American Can Co., New York, N. Y. Filed June 11, 1948. 5 claims. (Cl. 93-94.) A method of making spirally wound multi-ply composite tubes having an inner ply of metal foil.

2,605,034. Carrier for bottles and cans. Marshall I. Williamson, assignor to National Folding Box Co., Inc., New Haven, Conn. Filed Aug. 3, 1950. 6 claims. (Cl. 224-48.) A bottle carrier is equipped with a paperboard strap handle.

2,605,035. Carrier for bottles and cans. Marshall I. Williamson, assignor to National Folding Box Co., New Haven, Conn. Filed Aug. 3, 1950. 3 claims. (Cl. 224-48.) The method of engagement of a paperboard strap handle to a bottle carrier is claimed.

2,605,038. Article dispensing paper carton. William J. Wells, assignor to F. N. Burt Co., Inc., Buffalo, N. Y. Filed Feb. 14, 1948. 7 claims. (Cl. 229-17.) A dispensing carton for gum, candy, and the like has the closure flap near one end of the container.

2,605,039. Inner compartment for candy boxes. Irving A. Deline, Denver, Colo. Filed Aug. 20, 1949. 1 claim. (Cl. 229-42.) An inner subbox divides a candy box into a plurality of compartments.

2,605,040. Bag construction. Daniel Belcher, assignor to Bemis Bro. Bag Co., Minneapolis, Minn. Filed April 12, 1948. 3 claims. (Cl. 229-55.) The lower two thirds of the bag is of cellophane and the upper third consists of a more rigid material which will support the closure mechanism.

2,605,041. Handle for suitcase-type containers. Charles D. Welshenbach, assignor to The Hinde & Dauch Paper Co., Sandusky, Ohio. Filed June 19, 1948. 4 claims. (Cl. 229-52.) The handle is formed of a folded strip of paper which is interlocked to the top wall member.

2,605,101. Tension control system. Gerhard P. Lessmann, assignor to Westinghouse Electric Corp., East Pittsburgh, Pa. Filed Oct. 19, 1945. 8 claims. (Cl. 318-6.) A mechanical pressure type of resistance regulator is connected to a tensiometer-roll shaft so that excessive movement of the tensiometer shaft cannot damage the relatively delicate regulator.

2,605,168. Process for the preparation of chlorine dioxide. Ernst Wagner, assignor to Deutsche Gold- und Silber-Scheideanstalt vormals Roessler, Frankfort-on-the-Main, Germany. Filed June 6, 1949. 5 claims. (Cl. 23-152.) Sodium chlorate is oxidized with air in the presence of sulphuric acid.

2,605,328. Flexible web coated with an ethylcellulose composition. Milton H. Pintell, Richmond, Va. Filed April 14, 1949. 1 claim. (Cl. 117-122.) A label-coating agent contains 5.2% *o*-terphenyl and 17.5% ethylcellulose in a suitable solvent.

August 5, 1952

2,605,679. Prebreaking mechanism for carton blanks. Orme Welsh and Elmer D. Noreen, St. Paul, Minn., assignors to The Sperry Corp. Filed July 9, 1949. 7 claims. (Cl. 93-37.) The mechanism is designed for preliminarily breaking of cartons or boards along lines on which they are to be subsequently folded in order to facilitate the subsequent folding operations.

2,605,740. Machine for applying adhesive to paper and the like. Edgar F. Taylor, Nottingham, and Albert H. Williams, Bunny, England. Filed Dec. 22, 1948. 5 claims. (Cl. 118-236.) The apparatus consists of gripping devices which feed a sheet of paper from a stack to a roller coated with adhesive and means for peeling the paper from the roller.

2,605,794. Hydraulic log barker with traveling jets and automatic and manual controls. Herbert W. Guettler, San Francisco, Calif. Filed March 26, 1949. 10 claims. (Cl. 144-208.) A high-pressure water jet is projected against the log while the latter is rotated. The nozzle head comprises a plurality of nozzles, each having a jet opening for projecting a high-pressure water jet against the logs; water under appropriate pressure can be admitted to the nozzles selectively or simultaneously.

2,605,855. Method of making acoustic diaphragms. Frank B. Lenz, assignor to Hawley Products Co., St. Charles, Ill. Filed Dec. 22, 1948. 6 claims. (Cl. 18-56.) A molded pulp diaphragm is dampened and subjected to a pressure molding operation which has a marked lowering effect on the natural resonance.

2,605,892. Dispensing container. Donald Waber and Raymond Braunster, Jr., Philadelphia, Pa. Filed July 6, 1951. 9 claims. (Cl. 206-42.) The container has a substantially central exit, relative to the sides of the container and at the bottom of the latter.

2,605,893. Bottle cap display structure. James P. H. Leavitt assignor to Container Corp. of America, Chicago, Ill. Filed March 26, 1951. 6 claims. (Cl. 206-44.11.)

2,605,894. Hollow wall carton formed of two blanks. William P. Frankenstein, Cincinnati, Ohio. Filed Jan. 8, 1946. 13 claims. (Cl. 206-45.22.) A container the lid of which acts as an easel for display purposes.

2,605,951. Carton. Martin Burger, assignor to Shellmar Products Corp., Chicago, Ill. Filed Aug. 24, 1946, 4 claims. (Cl. 229-28.) A cellular egg carton is formed of one blank in such a manner that it can be assembled without an adhesive.

2,605,952. Collapsible cellular carton. Kenneth T. Buttery, assignor to Sutherland Paper Co., Kalamazoo, Mich. Filed Jan. 22, 1947. 1 claim. (Cl. 229-28.) In an egg carton formed from an integral blank, the end walls are so designed that they are not easily disengaged.

2,605,953. Hollow-walled box. Marshall I. Williamson, New Haven, Conn. Filed June 19, 1951. 7 claims. (Cl. 229-34.) The invention provides wall constructions covering a considerable range of angles for the inside and the outside panels and also permits the box blanks to be prefolded and preglued.

2,605,954. Hollow-walled box. Marshall I. Williamson, New Haven, Conn. Filed June 19, 1951. 6 claims. (Cl. 229-34.) This is similar to the previous patent.

2,605,955. Self-locking folding box. Reginald B. Meller, Oakland, Calif., assignor to Bemiss-Jason Co. Filed Dec. 16, 1947. 6 claims. (Cl. 229-35.) The invention provides an improved interlock for rigidly connecting overlapping portions of a blank of foldable sheet material.

2,606,094. Process of degumming bast fibers. Mazy Byrne, West Palm Beach, Fla. Filed Aug. 22, 1949. 8 claims. (Cl. 92-4.) Bast fibers are degummed by soaking at room temperature with a solution of a soluble salt of an alkylated aryl polyether sulphate.

2,606,103. Chemical recovery furnace with high-temperature superheater. Alexander L. Hamm, assignor to Combustion Engineering-Superheater, Inc., New York, N. Y. Filed June 13, 1947. 5 claims. (Cl. 23-262.) The invention provides means for obtaining relatively high steam temperatures in superheaters associated with chemical recovery furnaces.

2,606,114. Continuous pulp digester. Robert G. Lewis, Chippawa Falls, Wis., assignor of one half to Sidney D. Wells. Filed Nov. 1, 1946. 7 claims. (Cl. 92-7.) The apparatus consists of at least two digesters and a heat exchanger. White liquor is passed through the heat exchanger in a direction countercurrent to the flow of stock.

2,606,115. Process for modifying wood pulp for rapid dispersion. Albert C. Nuessle and William P. Hall, assignor to Joseph Bancroft & Sons Co., Wilmington, Del. Filed March 23, 1946. 6 claims. (Cl. 92-21.) The pulp sheets are treated with an aqueous solution of a strong acid and an organic nitrogen-containing base, dried, and cured by heat. The product is substantially flame, glow, and mildew resistant.

August 12, 1952

2,606,411. Method of making packages. Oscar H. Hultin, assignor to Pneumatic Scale Corp., Ltd., Quincy, Mass. Filed May 28, 1947. 1 claim. (Cl. 53-8.) A rectangular bag is made of parchment paper, cellophane, or the like and is protected by a sleeve of containerboard.

2,606,520. Paper-coating machine. Leroy W. Hoel, assignor, to Paper Patents Co., Neenah, Wis. Filed March 12, 1949. 4 claims. (Cl. 118-249.) The invention is designed to eliminate so-called "chatter marks" from coated papers.

2,606,521. Adhesive applying apparatus for cigarette making machines. William E. Wray, assignor to The American Tobacco Company, New York, N. Y. Filed March 10, 1950. 2 claims. (Cl. 118-410.)

2,606,651. Protective container for pies and cakes. John S. Bencich, San Francisco, Calif. Filed March 29, 1948. 1 claim. (Cl. 206-4.) The container consists of substantially complemental sections with locking means.

2,606,653. Display container. Vernis G. Knudson, assignor to Treasure Masters Corp., Minneapolis, Minn. Filed Jan. 20, 1951. 4 claims. (Cl. 206-44.12.) The container is designed for the display of greeting cards.

2,606,655. Commodity dispensing package and wrapper therefor. Shy Rosen, assignor to Milprint, Inc., Milwaukee, Wis. Filed Oct. 30, 1947. 2 claims. (Cl. 206-57.) A container for dispensing sanitary napkins and other tissues from a pocket-size pack.

2,606,669. Sheet conveying, stacking, and delivering apparatus. Hugh S. Morrison, assignor to Fairfield Paper and Container Co., Baltimore, Ohio. Filed April 14, 1950. 12 claims. (Cl. 214-6.) This is a continuation of U. S. patent 2,506,550;

the present invention provides an improved gate structure which prevents jamming of the sheets.

2,606,709. Shipping case. Troy L. Carey and Isadore Lubersky, assignors to Fibreboard Products Inc., San Francisco, Calif. Filed July 3, 1948. 2 claims. (Cl. 229-23.) The shipping case has a bottomless outer shell, an inner liner adapted to be telescoped within the outer shell, and an outer inner liner to be telescoped within the inner liner.

2,606,710. Partitioned container. Jules M. Reaves, assignor of 50% to Heiskell Weatherford, Jr., Memphis, Tenn. Filed June 21, 1948. 4 claims. (Cl. 229-27.) A container for butter or oleomargarine is capable of receiving and retaining dividers.

2,606,711. Compartmental folded paperboard carrier with handle. Homer W. Forrer, assignor to Atlanta Paper Co., Atlanta, Ga. Filed Sept. 15, 1950. 6 claims. (Cl. 229-27.) A carrier for small jars and cans has a medial partition which defines two compartments and provides a central panel from which the carrier may be suspended.

2,606,712. Bottle carrier. Michael H. Kowal, assignor to Empire Box Corp., Garfield, N. J. Filed March 24, 1949. 1 claim. (Cl. 229-28.) The two rows of bottles are effectually separated by a solid central partition which also serves as a connector for a separate handle.

2,606,775. Manifolding. Douglas A. Newman, assignor to Columbia Ribbon and Carbon Manufacturing Company, Inc., Glen Cove, N. Y. Filed March 23, 1946. 1 claim. (Cl. 282-28.) A record sheet for manifolding purposes.

2,606,842. Stabilized rosin size. Charles C. Price, assignor to Hercules Powder Co., Wilmington, Del. Filed Oct. 25, 1947. 13 claims. (Cl. 106-218.) A stabilized paste rosin size consists of rosin, saponified rosin, or mixtures thereof which contain from 0.5 to 3% of an aryl nitro compound, such as *m*-dinitrobenzene, 1,3,5-trinitrobenzene, or trinitrotoluene.

2,606,851. Phonograph record and method of manufacture. Eugene D. O'Mahony and George P. Humfeld, assignors to Radio Corp. of America, New York, N. Y. Filed Nov. 12, 1948. 12 claims. (Cl. 154-43.) The core of a phonograph record consists of felted paper pulp impregnated with zein, which may be modified with Vinsol resin or rosin. The surfaces are paper sheets coated with a thermoplastic resin, such as ethylcellulose or vinyl chloride-acetate copolymer.

2,606,884. Adhesive comprising Vinsol and a butadiene-acrylonitrile synthetic rubber. Evart E. Mayfield, assignor to Hercules Powder Co., Wilmington, Del. Filed April 27, 1950. 11 claims. (Cl. 260-27.) A mixture of Vinsol and a substantially completely polymerized butadiene-acrylonitrile copolymer in the ratio of 1:3 to 3:2 is suitable as a laminant for paper, cellophane, and the like.

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2,607,486. Iron oxide flotation process. James A. Barr, Jr., assignor to Armour and Co., Chicago, Ill. Filed Aug. 30, 1946. 2 claims. (Cl. 209-166.) The collector is a sulphonated or sulphated tall oil from which the bulk of the abietic acid has been removed.

2,607,501. Apparatus for stacking wallboard panels and the like. Douglas C. Jeffrey, assignor to National Gypsum Co., Buffalo, N. Y. Filed June 25, 1947. 13 claims. (Cl. 214-6.) The apparatus receives a continuously moving line of wallboard bundles and automatically stacks them on a transportable supporting structure into a plurality of contiguous columns.

2,607,504. Bottle closure. Rudolph Sonnenberg, assignor to Mid-West Bottle Cap Co., Belvidere, Ill. Filed Sept. 19, 1947. 2 claims. (Cl. 215-29.) A milk bottle cap is formed of a laminate of paper and metal foil with microcrystalline wax.

2,607,524. Envelope structure, Fred Gerson, Elmhurst, N. Y. Filed June 25, 1949. 1 claim. (Cl. 229-72.) An envelope for hardware items has a corrugated partition which divides it in various sized compartments.

2,607,678. Method of deinking waste paper. Louis J. Scheid, assignor to Watervliiet Paper Co., Watervliiet, Mich. Filed Aug. 5, 1947. 5 claims. (Cl. 92-1.5.) Paper with a saponifiable oil-base ink is saponified with sodium hydroxide and treated with carbon tetrachloride, with soybean flour as an emulsifying agent.

2,607,679. Apparatus for removing liquid from cotton linters. Clarence B. Weiss and Charles W. Dean, assignors to Buckeye Cotton Oil Co., Memphis, Tenn. Filed Feb. 17, 1947. 3 claims. (Cl. 100-98.)

2,607,680. Apparatus and method for processing vegetable fibers. Clarence B. Weiss and Charles W. Dean, assignors to Buckeye Cotton Oil Co., Memphis, Tenn. Filed Feb. 17, 1947. 2 claims. (Cl. 92-7.) Cotton linters are treated in the above apparatus with 2.5% alkali at a pressure of 100 p.s.i. The viscosity of the resulting cellulose is about 3000 seconds.

2,607,711. Adhesive tapes and liners having low-adhesion coatings. James O. Hendricks, assignor to Minnesota Mining & Manufacturing Co., St. Paul, Minn. Filed Oct. 27, 1949. 13 claims. (Cl. 117-122.)

2,607,712. Extrusion coating machine. Robert C. Sturken, assignor to Frank W. Egan & Co., New Brunswick, N. J. Filed Jan. 28, 1952. 4 claims. (Cl. 154-1.) A machine is capable of binding a thin sheet of hot thermoplastic material to the surface of paper.

2,607,823. Crepe paper cable insulation. Guglielmo Camilli and Leo Mulligan, assignors to General Electric Co., Schenectady, N. Y. Filed Sept. 28, 1949. 6 claims. (Cl. 174-124.) A plurality of layers of calendered crepe paper is wound in a spiral about the conductor.

2,607,824. Two-way stretch paper in insulated cables. Guglielmo Camilli and Leo Mulligan, assignors to General Electric Co., Schenectady, N. Y. Filed Dec. 21, 1950. 4 claims. (Cl. 174-124.) The crepe paper tape has two crepings substantially perpendicular to each other so that each individual layer of the tape can stretch in two directions. The cables in these patents are capable of withstanding sharp cable bends.

August 26, 1952

2,608,139. Apparatus for setting up paper receptacles. Ralph R. Richardson and Don W. Coy, assignors to Chicago Carton Co., Chicago, Ill. Filed Sept. 29, 1949. 13 claims. (Cl. 93-49.) The mechanism provides means for automatically inserting locking tongues formed in certain walls of the receptacle through slits in other walls thereof.

2,608,140. Shot shell manufacture. Walter L. Finlay and Dorothy R. Adessa, assignors to Remington Arms Co., Inc., Bridgeport, Conn. Filed Feb. 15, 1947. 2 claims. (Cl. 93-83.) A method is described for the manufacture of shot shell bodies from Fourdrinier kraft paper.

2,608,223. Portable log debarker. Henrik J. Eklund and Clarence W. Miller, assignors to D. J. Murray Manufacturing Co., Wausau, Wis. Filed Feb. 5, 1949. 7 claims. (Cl. 144-208.) The construction of a revolving chain-type portable debarker is described.

2,608,224. Chain-type log barker. Henrik J. Eklund and Clarence W. Miller, assignors to D. J. Murray Manufacturing Co., Wausau, Wis. Filed Nov. 28, 1949. 9 claims. (Cl. 144-208.) An annular series of alternately oppositely inclined chains is revolvably suspended so that the rotor assemblage will automatically centralize itself relative to the logs as it is brought into active position.

2,608,338. Egg carton. Martin Burger, assignor to Shellmar Products Corp., Chicago, Ill. Filed Nov. 21, 1945. 7 claims. (Cl. 229-28.) A fiberboard egg carton includes a longitudinal partition and a plurality of transverse partitions.

2,608,339. Cardboard packing. Boye Benzon-Petersen, assignor to Aktiebolaget Akerlund & Rausing, Lund, Sweden. Filed April 8, 1946. 8 claims. (Cl. 229-28.) The subdivision of containers (intended for glassware, china, and the like) into a number of individual cells is effected by means of a sinuous strip of cardboard and a number of parallel extending strips.

2,608,340. Container. John S. Donnell, assignor to Florida Fibre Box Co., Sarasota, Fla. Filed July 28, 1949. 1 claim. (Cl. 229-33.) A shipping container for fruits and vegetables is formed of double-faced corrugated board with single thickness end walls and double thickness side walls.

2,608,341. Fiber container with improved tearing strip. George E. Eckman, assignor to American Can Co., New York, N. Y. Filed Oct. 20, 1947. 1 claim. (Cl. 229-51.) A fibrous container for frozen foods and the like has a tearing strip which is defined by score lines arranged on both sides of the material of the body of the container.

2,608,467. Production of sulphur dioxide. Warren K. Lewis, assignor to Standard Oil Development Co., Linden, N. J. Filed Dec. 22, 1948. 7 claims. (Cl. 23-179.) Pure sulphur dioxide free of oxygen and sulphur contaminants can be continuously prepared by burning sulphur, hydrogen sulphide, or sulphur-containing ores and passing the gases through a purification zone containing a mixture of iron oxides (50% Fe_2O_3 and 50% Fe_3O_4).

2,608,492. Insulation board. Margaret E. Mueller, New York, N. Y. Filed Dec. 19, 1944. 5 claims. (Cl. 92-3.) A method of forming a board from hemp or flax shives.

2,608,503. Method of making adhesive tapes and adhesive units. Frank J. Meyer, East Orange, N. J. Filed Sept. 16, 1950. 12 claims. (Cl. 154-118.) An adhesive tape of paper, coated on both sides or impregnated with a normally tacky, pressure-sensitive adhesive, is provided with a liner strip of Holland cloth, polyethylene, or other material.

2,608,537. Lignin reinforced rubber and method of making same. Arthur Pollak, assignor to West Virginia Pulp and Paper Co., New York, N. Y. Filed July 12, 1947. 53 claims. (Cl. 260-17.5.) A solution is prepared by adding 10 lb. of 50% sodium hydroxide to a slurry of 25 lb. of lignin in 65 lb. of water. Ten pounds of this 25% lignin solution are mixed with 25 lb. of GR-S latex and the mixture is added to 0.8% sulphuric acid at 194°F.

September 2, 1952

2,608,857. Mount for tensile testing specimens of textile materials. Richard R. La Torre and Thomas W. George, Washington, D. C. Filed Aug. 12, 1949. 4 claims. (Cl. 73-103.) A mounting head for a tensile tester is so constructed that all parts of the specimen under stress are maintained in precise axial alignment with the direction of stress application.

2,608,910. Screening of fibrous material. John McCrystle, New Brunswick, N. J. Filed April 26, 1946. 5 claims. (Cl. 92-20.) In the operation of a flat screen with a pulp consistency of 0.5 to 2%, positive jet streams of water under pressure are introduced at an angle of less than 75° to the plane of the screen; the water is so introduced that the entire operating areas of the screen are directly subjected to its action.

2,608,911. Concrete form lining material. Orcutt W. Frost and James H. Conover, assignors to United States Gypsum Co., Chicago, Ill. Filed May 1, 1946. 13 claims. (Cl. 92-40.) A wet mat is formed of pulp to which rosin size and alum have been added; before the mat is dried, it is treated with a composition containing 10° parts of furfural (or formaldehyde) and 20 parts of sodium hydroxide in 300 parts of water; upon drying, the sizing effect in the outer part of the board is destroyed, so that concrete or cement will not adhere to it.

2,608,912. Apparatus for producing paper. Harold M. Davis, assignor to Precision Paper, Inc., Calais, Vt. Filed Feb. 23, 1949. 13 claims. (Cl. 92-44.) The invention relates to a method of and means for controlling the flow and character of the pulp stream as it leaves the head box. This is accomplished by the use of a plurality of baffles in the head box with means for supporting them in close proximity to the bottom portion of the box.

2,608,913. Suction box connection to manifold. Samuel M. Bratton, assignor to The Pusey & Jones Corp., Wilmington, Del. Filed Oct. 15, 1946. 17 claims. (Cl. 92-51.) The invention provides, in combination with a vertically adjustable Fourdrinier machine having suction boxes carried by the supporting rail thereof, a fixed manifold connected to the suction and discharge lines and a vertically adjustable connection, including a slidable joint between a coupling conduit section.

2,608,916. Carton-folding mechanism. Robert J. Hickin, assignor to The Ohio Boxboard Co., Rittman, Ohio. Filed Oct. 4, 1950. 9 claims. (Cl. 93-51.)

2,608,917. Folding machine. Charles Hess, assignor to S&S Corrugated Paper Machinery Co., Inc., Brooklyn, N. Y. Filed Nov. 20, 1947. 2 claims. (Cl. 93-52.) A pair of deflecting bars cooperate with folding slats to deflect the side panels upward as the blank passes through the machine.

2,608,949. Glue-spotting apparatus. Felice G. Pasotti, assignor to Ball Brothers Co., Muncie, Ind. Filed Nov. 28, 1947. 8 claims. (Cl. 118-8.) A method of applying glue to cartons to hold them in assemble relationship.

2,609,135. Container. Dennis I. McKenzie, assignor to Moraine Box Co., Dayton, Ohio. Filed Feb. 17, 1948. 7 claims. (Cl. 229-14.) A wooden crate type of reinforcement structure for a cardboard container.

2,609,136. Packing element. Nicholas M. Sider, assignor to Container Corp. of America, Chicago, Ill. Filed Sept. 19, 1947. 4 claims. (Cl. 229-14.) A packing element is formed with a truss construction which prevents deformation.

2,609,137. Carton. Patrick A. Toensmeier, assignor to The Bartgis Brothers Co., Ilchester, Md. Filed Nov. 13, 1950. 5 claims. (Cl. 229-15.) The construction of a paper handle for a bottle carrier is claimed.

2,609,138. Carton and carton blank. Arthur J. Weiss, assignor to Robert Gair Co., Inc., New York, N. Y. Filed Dec. 26, 1946. 2 claims. (Cl. 229-16.) A method of forming a siftproof carton is described.

2,609,157. Winding apparatus. Jes Asmussen and Frank Gruper, assignor to Marathon Corp., Rothchild, Wis. Filed Nov. 12, 1947. 3 claims. (Cl. 242-66.) Means are provided for controlling the pressure and tension of the web by compensating for the normal increase in pressure and tension upon the web as it is being wound.

2,609,284. Coated abrasive article and method of making. Leonard R. Nestor, assignor to Minnesota Mining & Manufacturing Co., St. Paul, Minn. Filed June 28, 1947. 7 claims. (Cl. 51-302.) An alkali-converted oxidized starch is used for bonding grit to sandpaper.

2,609,321. Craze-resistant resinous coating, coated product, and process of making it. Donald G. Patterson, assignor to American Cyanamid Co., New York, N. Y. Filed May 7, 1948. 10 claims. (Cl. 154-121.) A laminated product has a coating of a melamine-formaldehyde or urea-formaldehyde resin and glass fibers.

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2,609,732. Cylinder papermaking machine. Roy H. Breyfogle, assignor to Alton Box Board Co., Alton, Ill. Filed March 14, 1946. 2 claims. (Cl. 92-43.) A cylinder machine is provided with means for introducing white water or other diluting liquor into the vat circle of the machine; the quantity of liquid is such as to maintain consistent stock consistency throughout the entire vat circle.

2,609,733. Method of molding magnesia insulation material. Roland W. Honnig, assignor to Johns-Manville Corp., New York N. Y. Filed Oct. 26, 1945. 14 claims. (Cl. 92-54.) A method of forming a light weight, strong magnesia block from magnesium carbonate and asbestos fibers.

2,609,735. Apparatus for sealing containers. Robert A. Farrell and William G. Mueller, assignor to Marathon Corp., Rothschild, Wis. Filed July 18, 1947. 7 claims. (Cl. 93-39.1.) A method is given for molding and sealing a thermoplastic or thermoplastic-coated flexible sealing membrane within the opening of a tubular carton and onto its flaps.

2,609,736. Machine for folding paper box blanks on a stack thereof. Hugh E. Montgomery, Jacksonville, Fla. Filed June 3, 1948. 6 claims. (Cl. 93-49.) The machine operates on the topmost blank while it is still in the stack.

2,609,923. Bag package with fork-life handling means. Budd E. Simonton, assignor to St. Regis Paper Co., New York, N. Y. Filed Oct. 27, 1949. 3 claims. (Cl. 206-60.) A method is described for packing loads of multiwall bags for shipment.

2,609,981. Tumbler-carrying carton. Hubert V. Bolding, assignor to The Bradley & Gilbert Co., Louisville, Ky. Filed April 11, 1950. 4 claims. (Cl. 224.48.) The carton contains dividers for separating the body of the container into individual glass-receiving cells.

2,609,985. Container with flat top and integral overcap. George C. Reid and Samuel S. Jacobs, assignors to American Can Co., New York, N. Y. Filed May 22, 1947. 3 claims. (Cl. 229-7.) The patent covers a top of a milk container and the like.

2,610,119. Defibering presoaked lignocellulose. Gunnar Magnuson, assignor to Aktiebolaget Defibrator, Stockholm, Sweden. Filed Sept. 14, 1946. 1 claim. (Cl. 92-6.) Chips are soaked at room temperature for 4 to 28 hr in an aqueous solution of an alkali hydroxide, alkali sulphite, acid, or salt and then digested by the Asplund process.

2,610,136. Manufacture of corrugated paperboard. James P. Casey, Lowell O. Gill, and Robert A. Sherman, assignors to A. E. Staley Manufacturing Co., Decatur, Ill. Filed May 1, 1946. 2 claims. (Cl. 154-33.05.) An adhesive for corrugated paperboard consists of partially hydrated starch granules in a nongelatinous aqueous medium. Methods for the preparation of the starch are given.

2,610,138. Manufacture of resin-bound fiber structure. Clark C. Heritage, assignor to Wood Conversion Co., St. Paul, Minn. Filed Nov. 27, 1945. 2 claims. (Cl. 154-101.) A method is described for forming a fiber blanket from cellulosic fibers and a phenol-formaldehyde resin.

2,610,160. Wallboard containing a phenol formaldehyde resin and cattail fibers. Estelle M. S. Muncio, New Orleans, La. Filed Feb. 14, 1951. 4 claims. (Cl. 260-17.2.) Cattail fibers, treated with a phenol- or resorcinol-formaldehyde resin and an acid catalyst, are formed into an insulation board.

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2,610,517. Belt drive for papermaking machines. Lloyd Hornbostel, assignor to Beloit Iron Works, Beloit, Wis. Filed March 11, 1946. 8 claims. (Cl. 74-242.11.) The invention covers a belt-slack adjusting mechanism.

2,610,553. Controlled flow beater. Frank Hayes, assignor to The Noble & Wood Machine Co., Hoosick Falls, N. Y. Filed Feb. 26, 1951. 4 claims. (Cl. 92-22.) The beater roll has a cell spacing greater than 0.24 and less than 1 in.; means are provided for controlling the flow of the stock to the roll under velocity and in small quantity sufficient only to cover the edges of the bars which define the small cells.

2,610,554. Jordan engine plug construction. Harold D. Stuck, assignor to John W. Bolton & Sons, Inc., Lawrence, Mass. Filed Dec. 17, 1947. 3 claims. (Cl. 92-37.) The major parts of the castings forming the outside body are replaced by an outside hollow truncated conical jacket which preferably has longitudinal grooves in which the plug bars can be fixed.

2,610,555. Method for producing shingle stock. John A. Romano, Berkeley Heights, N. J. Filed May 27, 1946. 2 claims. (Cl. 92-67.) A method of forming shingles of the asbestos-cement type is claimed.

2,610,556. Device for making tubes from sheet material. Francis C. Worth, Ridgewood, N. Y. Filed Aug. 25, 1950. 16 claims. (Cl. 93-77.) A machine is designed for applying labels to various articles, such as flexible or rigid containers, balls of thread, and the like.

2,610,581. Multicolor proof press. David D. Vandercook, Edward O. Vandercook, and Raymond L. Pelland, assignors to Vandercook & Sons, Inc., Chicago, Ill. Filed March 22, 1947.

14 claims. (Cl. 101-208.) A proof press is designed for testing the suitability of paper for multicolor printing.

2,610,756. Straight-sided stacking tote or packing box. Wilson F. Best, Grand Rapids, Mich. Filed April 7, 1950. 5 claims. (Cl. 220-4.) The box is formed of a metal bottom and fiberboard end and side walls.

2,610,782. Box. Henry L. Metzger, Castleton-on-Hudson, N. Y. Filed Jan. 7, 1948. 4 claims. (Cl. 229-16.) A container for cheese.

2,610,782. Interlocking sections for paper boxes. Ronald McReary, Corvallis, Ore. Filed Jan. 28, 1950. 6 claims. (Cl. 229-33.) An interlocking means is an integral part of the box.

2,610,783. Self-locking box. Thomas Ochar, Little Falls, N. Y. Filed Nov. 9, 1950. 2 claims. (Cl. 229-45.) The locking lungs are formed from end flaps folded back upon themselves so as to provide a double thickness.

2,610,784. Continuously attached envelopes. Beulah L. Henry, New York, N. Y. Filed Oct. 18, 1949. 4 claims. (Cl. 229-69.) Envelopes are connected together in strip formation to permit feeding through a typewriter or addressograph.

2,610,905. Accelerated settling of bleach impurities. Jerrold O. Hinshaw, assignor to Purex Corp., Ltd., South Gate, Calif. Filed June 9, 1950. 4 claims. (Cl. 23-86.) In the preparation of sodium hypochlorite, the chlorination is carried to the point where no appreciable amount of free sodium hydroxide remains, after which about 0.5% free sodium hydroxide is added.

2,610,920. Flameproofing composition. Harry Hopkinson, Lawrenceville, N. J. Filed Nov. 1, 1948. 7 claims. (Cl. 106-15.) The basis is a chlorinated organic material in combination with a metallic oxide.

2,610,924. Resinous adhesive composition. Raymond R. Lamm, assignor to the Patent and Licensing Corp., New York, N. Y. Filed May 1, 1948. 2 claims. (Cl. 106-240.) The adhesive consists of limed rosin, a paraffin wax-naphthalene condensate, and clay.

2,610,928. Mineralized bituminous roofing. Harold W. Greider and George A. Fasold, assignors to The Philip Carey Manufacturing Co., Cincinnati, Ohio. Filed Aug. 7, 1943. 2 claims. (Cl. 117-168.) Roofing felt is coated with an asphalt (32%) and a filler composed of 47% of powdered limestone and 21% of asbestos dust.

2,610,934. Method of and apparatus for making honeycomb material. Roger C. Steele, assignor to California Reinforced Plastics Co., Berkeley, Calif. Filed Nov. 22, 1948. 13 claims. (Cl. 154-1.8.) A machine has means for applying glue lines to an elongated sheet and means for lapping into superposed layers which may be formed into a honeycomb structure.

2,610,935. Creped paper product and process. William W. Rowe, assignor to Cincinnati Industries, Inc., Lockland, Ohio. Filed Feb. 24, 1949. 18 claims. (Cl. 154-33.05.) A water dispersion of a thermoplastic adhesive is used in the creping operation.

2,610,936. Reinforced paper article. Arthur E. Carlson, Hingham, Mass. Filed Aug. 10, 1949. 17 claims. (Cl. 154-53.5.) Paper is reinforced with rayon, nylon, or other synthetic material.

2,610,939. Method of laminating glassine paper. Jacob L. Fisher and George C. Borden, Jr., assignors to Riegel Paper Corp., New York, N. Y. Filed Dec. 26, 1946. 8 claims. (Cl. 154-138.) A laminating agent for glassine sheets consists of about 83% of amorphous wax, about 12% of polymerized rosin, about 3% of a viscous polybutene, and about 2% of "butyl" resin.

2,610,954. Oxidized alkali lignin as a rubber reinforcing agent. Rudolf A. V. Raff and George H. Tomlinson, Jr., assignors to Howard Smith Paper Mills Ltd., Montreal, Canada. Filed Feb. 27, 1948. 4 claims. (Cl. 260-17.6.) Oxidized alkali lignin with a melting point above 240°C. is used as a reinforcing agent for a GR-S rubber.

2,610,966. Process for treating tall oil with alkylene oxides. Vito Esposito, assignor to R. M. Hollingshead Corp., Camden, N. J. Filed Oct. 17, 1949. 9 claims. (Cl. 260-97.5.) The process of reacting tall oil with ethylene oxide is described. The resulting product is suitable for use in hydraulic fluid compositions.

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2,611,154. Method of pressing blanks of molded pulp. Eugene M. Chevrier, Montrouge, France. Filed Sept. 13, 1948. 3 claims. (Cl. 18-56.) A method is claimed for the surface pressing of blanks of molded pulp to form a cylindrical container; it is specially suitable for forming ribs or beads in the bottom wall of a container.

2,611,179. Cutting apparatus for wallboards and the like. Joseph F. Butler, Pittsburgh, Pa. Filed May 2, 1946. 2 claims. (Cl. 30-287.) An apparatus for cutting and scoring plaster board, gypsum board, and like materials.

2,611,225. Machinery for fabricating bags in various sizes. Victor G. Williams, assignor to Delamere & Williams Co. Ltd., Toronto, Ontario, Canada. Filed Dec. 30, 1948. 4 claims. (Cl. 53-88.) A machine is provided with simple adjustable means by which bags can be made in a variety of sizes.

2,611,298. Apparatus for making expanded sheet material. Carl B. Rowe, assignor to Research Products Corp., Madison, Wis. Filed Jan. 19, 1949. 4 claims. (Cl. 93-1.) An apparatus for expanding thin flexible material, such as paper, cloth, foil, and the like, slits the material and then stretches it to convert the slits into openings.

2,611,299. Feeding of collapsed cartons and the like. Alfred G. Rose and James Paige, assignors to Rose Brothers (Gainsborough) Ltd., Gainsborough, England. Filed Sept. 6, 1950. 5 claims. (Cl. 93-53.) A method is described for the feeding of collapsed cartons from a stack to a forwarding device which moves the carton to an operating device.

2,611,312. Embossing calender. Paul R. Illner, assignor to The Champion Paper and Fibre Co., Hamilton, Ohio. Filed Oct. 17, 1946. 2 claims. (Cl. 101-23.) An embossing calender, which will emboss a paper web on both sides in a single pass through the rolls, has an engraved pattern on the surface of each of two metallic rolls.

2,611,313. Duplicating method. Ray B. Keller and Harold B. Dawson, assignors to Hammermill Paper Co., Erie, Pa. Filed Dec. 10, 1946. 2 claims. (Cl. 101-149.4.) The master sheet (paper or the like) carries a coating of any suitable duplicating material and a protective coating of a waxy material.

2,611,401. Hydraulic log-barker having kerf-cutting and bark-removing jets. Robert E. Burton, Willits, Calif. Filed Oct. 17, 1950. 2 claims. (Cl. 144-208.) The barker utilizes the combined effect of at least two hydraulic jets, one of which is a leading jet which cuts through the bark and is followed by a peeling jet or jets which serve to peel the cut bark from the wood.

2,611,521. Carrier for chimed cans. Frank W. Hackman and William J. Poole, assignors to Container Corp. of America, Chicago, Ill. Filed Sept. 16, 1949. 1 claim. (Cl. 224-45.) A retaining flap construction in combination with a carrier for cans will cause the can to be held securely in the carrier by an inwardly extending retaining flap.

2,611,526. Heavy-duty shipping container. Walter C. George, assignor to Gaylord Container Corp., St. Louis, Mo. Filed Oct. 20, 1950. 2 claims. (Cl. 229-14.) A relatively tall, heavy-duty container is designed for the shipment of rayon yarn wound on cones.

2,611,527. Portable display carton. John V. Fisher, San Francisco, Calif. Filed Jan. 16, 1950. 4 claims. (Cl. 229-16.) A container for canned goods and the like is suitable as a carry-home item.

2,611,528. Container. Samuel Vadner, Cynwyd, Pa. Filed Aug. 1, 1950. 6 claims. (Cl. 229-23.) A container has high resistance to the stresses and strains imposed by relatively heavy supported loads.

2,611,529. Integral carton for protection of fragile articles. John F. Currivan, Dayton, Ohio. Filed Oct. 27, 1948. 9 claims. (Cl. 229-38.) A carton is described which is suitable for articles such as radio tubes.

2,611,530. Shipping carton with handhole reinforcing and flap securing clip. Walter C. George, assignor to Gaylord Container Corp., St. Louis, Mo. Filed Oct. 1 1948. 3 claims. (Cl. 229-52.) A bottle-shipping carton.

2,611,531. Two-lamp wrapper. Gordon A. Conkle, assignor to General Electric Co., Schenectady, N. Y. Filed Feb. 25, 1949. 4 claims. (Cl. 229-90.) A lamp wrapper has the form of a sleeve for holding and protecting a pair of incandescent lamps.

2,611,569. Paperboard pallet. Willits E. Coleman and James P. H. Leavitt, assignors to Container Corp. of America, Chicago, Ill. Filed March 26, 1948. 3 claims. (Cl. 248-120.) The construction of a disposable paperboard pallet which can be handled by a fork-lift truck is described.

2,611,682. Methods of recovering hydrogen sulphide from sulphide containing soda liquors obtained in cellulose production. Nils V. Mannbro, Fredricksberg, Sweden. Filed Dec. 4, 1950. 4 claims. (Cl. 23-181.) Hydrogen sulphide is recovered from the smelt containing sodium sulphide and sodium carbonate by passing a solution of the smelt and carbon dioxide-containing gas in counterflow through an absorption tower.

2,611,694. Fire-resistant sheet material. Hubert L. Becher, assignor to Homasote Co., Inc., Fernwood, N. J. Filed June 27, 1947. 6 claims. (Cl. 92-3.) A fire-resistant material contains 40 to 60% by weight of fiber, 20 to 40% of amine resin, 4 to 12% of a chlorinated resin and 12 to 20% of hydrated alumina.

2,611,717. Method of calendering mineral coated paper. Brainard E. Sooy and Harry C. Fisher, assignors to The Gardner Board and Carton Co., Middletown, Ohio. Filed Jan. 22, 1949. 2 claims. (Cl. 117-64.) The web, coated with a mineral substance, is treated while on the rolls with an aqueous solution of gelled starch having a solids content of 4.5 to 15% by weight.

2,611,752. Tackifiers and softeners for synthetic rubbers and compositions containing the same. Robert H. Barth, assignor to

Heyden Chemical Corp., New York, N. Y. Filed July 21, 1950. 18 claims. (Cl. 260-23.7.) The product is formed by heating 170 parts of tall oil and 748 parts of partial formals of pentaerythritol for 2 hr. at 275° and then refluxing with butyraldehyde and concentrated hydrochloric acid for 4 hr.

September 30, 1952

2,611,974. Method of measuring the moisture content of a running web. Nils N. Stråtveit, Oslo, and Arne Julius Schie, Drammen, Norway. Filed Sept. 26, 1949. 17 claims. (Cl. 34-41.) The decrease in the temperature of the web, caused by evaporation of water from the web, is used as a measure of the moisture content.

2,612,016. Folding and filling machine. Swan F. Anderson, assignor of one half to Ralph F. Anderson, Rockford, Ill. Filed Aug. 16, 1946. 13 claims. (Cl. 53-56.) The apparatus automatically sets up a knocked-down carton, fills it with ice cream, and then closes it.

2,612,083. Beater roll. Frank Hayes, assignor to Noble & Wood Machine Co., Hoosick Falls, N. Y. Filed Sept. 3, 1947. 4 claims. (Cl. 92-22.) The beater roll has a cell spacing greater than 0.24 and less than 1 in.; means are provided for controlling the flow of the stock to the roll under velocity and in small quantities sufficient only to cover the edges of the bars which define the small cells.

2,612,085. Apparatus for assembling partitions for packing cells. Richard C. Merry, Oakville, Ontario, Canada. Filed Sept. 22, 1948. 7 claims. (Cl. 93-37.) A machine is capable of forming the partitions and cross-partitions to form packing cells for bottled beverages, eggs, and other articles.

2,612,086. Cellular carton erecting machine. Harold R. Houtman, assignor to Sutherland Paper Co., Kalamazoo, Mich. Filed Dec. 4, 1950. 15 claims. (Cl. 93-37.) A machine is adapted to erect the partitions of egg cartons in which a part of the transverse partitions must be swung in one direction and a part in the opposite direction to erect them.

2,612,087. Machine for erecting cartons. Franklin M. Willbrandt, assignor to Sutherland Paper Co., Kalamazoo, Mich. Filed Oct. 7, 1949. 13 claims. (Cl. 93-49.) A machine is claimed for the erection of cartons comprising side walls hingedly connected to a bottom, one opposed pair of the walls having slits therein providing deflectable portions above the slit and the other pair having corner flaps provided with tongues engageable with such deflectable portions.

2,612,088. Closure flap folding and envelope stacking mechanism for envelope machines. Vincent E. Heywood, assignor to United States Envelope Co., Springfield, Mass. Filed July 13, 1948. 4 claims. (Cl. 93-62.)

2,612,190. Paper mill felt. Edward H. Hall, Fitchburg, Mass. Filed Jan. 27, 1949. 10 claims. (Cl. 139-426.) Pure nylon threads are used as the warp at the extreme edges of the felt; the warp threads in the margins may be wholly nylon or a mixture of nylon and cotton; this gives a felt with more durable edges and margins.

2,612,305. Container. Arthur P. Klasing and Benjamin M. Williams, assignors to Gaylord Container Corp., St. Louis, Mo. Filed Oct. 12, 1949. 5 claims. (Cl. 229-23.) The invention covers multiple-trip fiberboard bottle containers.

2,612,306. Carton. William P. Frankenstein, Cincinnati, Ohio. Filed July 17, 1946. 17 claims. (Cl. 229-31.) A foldable shipping container is so designed that the contents can be displayed and, after use, the container can be converted into a toy building.

2,612,307. Container closure. Frank H. Waggoner, Ramsey, N. J. Filed Dec. 16, 1949. 3 claims. (Cl. 229-44.) A top closure for a cereal container consists of two flexible overlapping flaps, one of which is wider than the other.

2,612,308. Box handle and fastening means. Roy C. Potts, Takoma Park, D. C. Filed Jan. 23, 1948. 11 claims. (Cl. 229-52.) Means are provided for the attachment of a wire handle to a fiberboard shipping container.

2 612,309. Combination handle and clip for containers. Roy C. Potts, Takoma Park, D. C. Filed Dec. 20, 1946. 6 claims. (Cl. 229-52.) The construction of containers for the shipment of eggs, fruits, and vegetables is claimed.

2,612,445. Process of making hardboard and the like containing furfuryl alcohol resin. Oswald Spence, assignor to Masonite Corp., Laurel, Miss. Filed July 30, 1949. 4 claims. (Cl. 92-21.) Masonite pulp is treated with a partially condensed water-insoluble furfuryl alcohol resin and the product is formed into a board about 0.5 in. thick and containing 16 to 20% resin by heat and pressure.

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The Sulfox Process for Recovering Chemicals from Sulphite Mills

ROBERT S. ARIES and ARTHUR POLLAK

For sulphite pulp mills the new Sulfox (sulphide oxidation) process provides an efficient reuse of pulping chemicals and the important associated benefit of greatly reduced stream pollution. The new process can eliminate over 95% of the worst source of pollution—the waste liquor—from sulphite mills not now recovering their waste liquors. This applies not only to the usual acid sulphite pulp mill but also to mills making neutral sulphite or neutral sulphite semi-chemical pulps. Many such pulps, known for their exceptional strength and high bleachability, have been held back by the lack of a suitable chemicals recovery process.

In the Sulfox process the usual lime or dolomite base of the sulphite cooking acid is replaced by a soda base. This soda can be supplied either as soda ash, salt cake, or sodium sulphite.

Most of the steps of the Sulfox process utilize equipment that can be assembled from items that have been on the market in standard sizes for years.

In brief, in the Sulfox process the waste liquor is collected, evaporated, burned, and smelted very much as now done in the sulphate pulp industry. The resulting smelt, mainly sodium sulphide and sodium carbonate, is then dissolved and subjected to a controlled air oxidation. This yields a mixture of sodium sulphite and sodium carbonate suitable for reuse in making up sulphite cooking liquor.

The process works with sulphite waste liquor alone or mixed with other waste liquor, such as that of the sulphate process without impairing its effectiveness or that of either of the pulp processes.

Estimates for installations in sulphite mills show costs lower than for sulphate recovery plants of the same pulp capacity. Most of the equipment is similar but there is much less ash per ton of pulp, and the cost of the dissolving and oxidizing units is less than the cost of the sulphate pulp mill lime reclaiming and caustic plants which would not be needed.

A general flowsheet illustrating the sequence of unit processes for a sulphite mill is shown in Fig. 1. More detailed flowsheets of the unit processes follow with explanations.

ADVANTAGES

The pulping cycle in the typical sulphite mill using a lime or dolomite base liquor needs no modifications in converting to a soda base. Much of the liquor-making facilities remain useful.

The use of soda instead of lime as base tends to improve pulp quality and is known to have been used commercially from time to time in a number of mills; a few mills are cooking with soda-base liquor today.

With soda as base, because of the high solubilities of all the constituents of the liquor, there can be no scale forming and no precipitation of sulphites or sulphates. This allows the increased use of blow-back and also makes indirect heaters much more practical. With indirect heaters there is less dilution and more chemicals can be charged into the digester—a considerable benefit when chips are tightly packed.

Burning the waste liquor provides heat for generating steam. The fuel value of this liquor is about 8000 B.t.u per pound of solids. While some of this steam is consumed in evaporating waste liquor, about 5000 lb. steam per ton pulp remain for use in the pulp mill.

The advantage of the large reduction in stream pollution possible with the process is too well known to warrant description here. The merit in conserving most of the sulphur now wasted is also obvious in view of its scarcity.

Robert S. Aries and Arthur Pollak, The Sulfox Corp., New York, N. Y.

WASTE LIQUOR SULPHUR

The composition of soda-base sulphite waste liquor is similar to that using other bases—lime, magnesia, or ammonia.

The molar ratio of sulphur to calcium in sulphite waste liquor is 1.9 to 2.0 before evaporation. This ratio of sulphur to base also applies to soda, S/Na_2O, and ammonia, $S/2NH_3$. Some typical data available in the literature on sulphite waste liquor composition are tabulated in Table I.

Table I. Sulphite Waste Liquor Compositions

Liquor	Ref.	Base	Base, %	Sulphur, %	Pound moles Per 1000 lb. solids Base	Pound moles Per 1000 lb. solids Sulphur	Ratio, sulphur: base
Digester liquor	(6)	CaO	7.7	8.8	1.38	2.75	2.0
Digester liquor	(9)	$2NH_3$	4.25	7.53	1.25	2.36	1.89
			3.86	6.53	1.13	2.04	1.80
Digester liquor	(4)	Na_2O	6.3	6.2	1.02	1.94	1.90
Evaporated liquor unneutralized	(7)	CaO	6.63	6.00	1.19	1.88	1.58

As with other bases having soluble sulphates the waste liquor carries in the new process, additionally, some inert sodium sulfate. About 20% of the total sodium in the liquor is inert as sodium sulphate.

This amount of sulphate does not appear to affect cooking conditions or the quality of the pulp. Mills cooking soda-base sulphite have been known to exceed this proportion of sulphate due to poor operating conditions in the liquor plant.

The sulphur content of sulphite waste liquors has been reported by a number of workers. One mill using lime base reports an average consumption of 253 lb. sulphur with 223 lb. sulphur in the waste liquor associated with 1 ton of pulp. The rest, 30 lb, was lost in the blow pit. Of this waste liquor sulphur, 178 lb. was organic, 45 lb. was inorganic, excess cooking chemicals, etc. (3).

For the purpose of this paper we might consider that the average cited above, of 223 lb. sulphur contained in the waste liquor per ton pulp as typical of lime-base liquor. For the proposed process this would need adjustment for inert sodium sulphate. At a ratio of $S/Na_2O = 2.0$, the active soda is then $223/2 \times 62/32 = 216$ lb. Na_2O. With 20% as inert soda this becomes $216/0.80 = 270$ lb. Na_2O (4.36 moles) per ton pulp.

The inert sulphur is then $(270 - 216) \times 32/62 = 28$ lb. sulphur. The total sulphur in waste liquor is thus $223 + 28 = 251$ lb. sulphur (7.84 moles) per ton pulp.

From the foregoing this sulphur is distributed as follows:

Table II. Distribution of Sulphur in Waste Liquor

Form	Sulphur, lb. per ton pulp	Per cent
Organic sulphur	178	71
Inorganic sulphites	45	18
Inorganic sulphate	28	11
Total	251	100

Soda Content

The liquor contains soda equivalent to the bases of other liquors. Allowing for the extra sodium sulphate this has been calculated in the previous paragraph to total 270 lb. Na_2O in the waste liquor per ton pulp.

This figure can be confirmed by calculations from cooking liquors. Thus, a ton of pulp uses 2200 gal. of cooking liquor (5), weighing 19,000 lb. With the typical 1.2% of combined SO_2 this means $0.012 \times 62/64 \times 19{,}000 = 221$ lb. Na_2O. Allowing for the extra sodium sulphate this becomes 276 lb. Na_2O, a very close check.

Total Solids

The solids content of sulphite waste liquor is approximately the sum of the sodium oxide, the sulphur dioxide, and the organic matter associated with a ton of pulp.

A ton of pulp is 1800 lb. of oven-dry pulp which, at a yield of 45% comes from 4000 lb. of wood, oven-dry basis. About 10% of the organic matter is lost as water of reaction, as gas and vapor—carbon dioxide, methanol, etc. Accordingly, the organic matter dissolved in waste liquor is then $0.90 \times 2200 = 1980$ lb.

The total solids is then this 1980 lb. of organic matter plus the 270 lb. of Na_2O and the 500 lb. of sulphur dioxide already computed—a total of 2750 lb.

The waste liquor from the digesters thus contains about 9.1% S and 9.8% Na_2O.

WASHING

In a properly designed and operated washing system it is practical to collect nearly all, 95% or better, of the waste liquor without undue dilution. The big point is to conserve all waste liquor so far as possible, that is, to avoid thinning with too much water. When too much water gets into the waste liquor it costs too much to evaporate. This means it must go to waste—to pollute nearby streams. Aside from the elimination of obvious leakage points, the principal feature of a good collection system is the reuse of all waters or liquors in progressive stages or in countercurrent flows. While this is not now the practice in the typical sulphite mill, such cycles are in common use in sulphate mills were the waste liquor is valued for its chemical content. No important obstacles are anticipated in applying such efficient washing cycles to sulphite mills.

A typical flowsheet for the collection of waste liquor in an efficient sulphite mill is shown in Fig. 2.

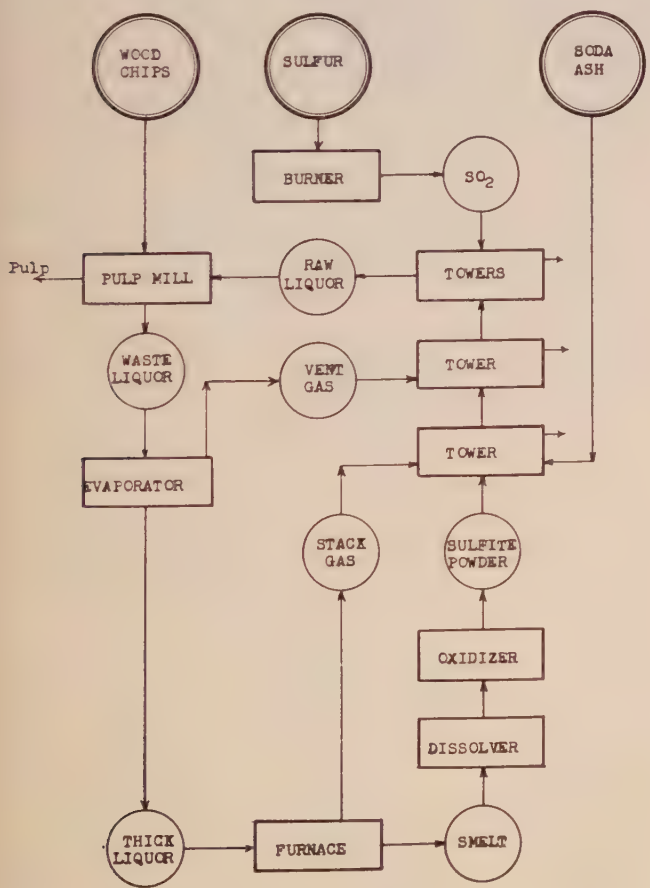

Fig. 1. General flow sheet of the Sulfox process for sulphite waste liquor

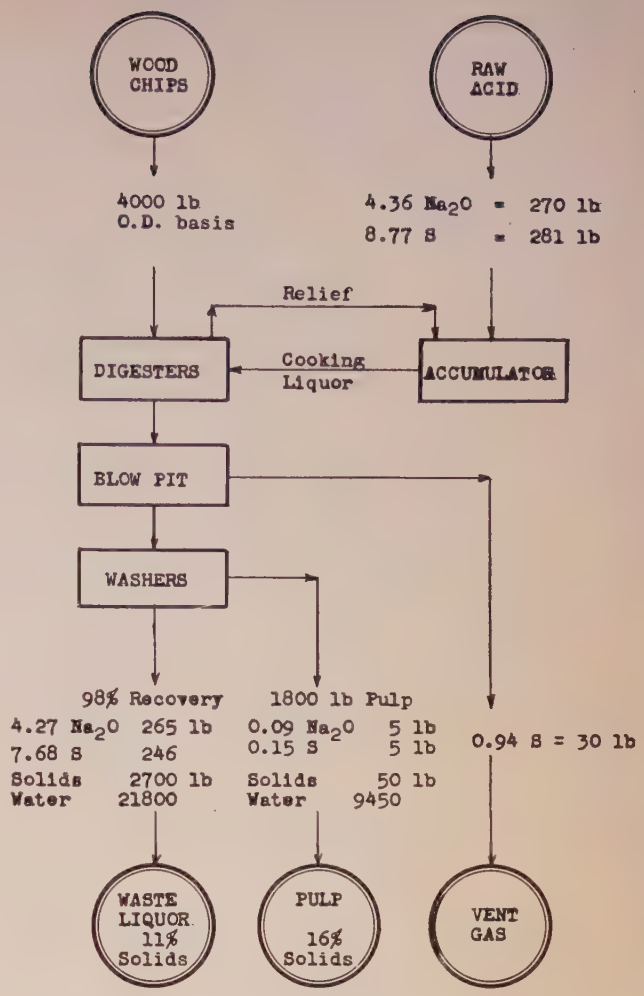

Fig. 2. Soda-base sulphite pulping process material balance

Basis 2000 lb. pulp, 90% oven dry

With modern vacuum washers not less than 98% of these chemicals are recoverable using 2.0 lb. of water per pound pulp for washing. This means that the liquor going to the evaporators will contain 2700 lb. of solids with 265 lb. Na_2O and 246 lb. S. The liquor solids concentration may be 11% or higher.

EVAPORATION

The evaporation of soda-base sulphite waste liquor is far simpler than lime-base liquor; there is no scaling due to lime deposits. The liquor may be evaporated directly or after neutralization. If neutralization is desired, soda for this is available from the recovery cycle.

The evaporation of soda-base sulphite waste liquor may be expected to parallel the performance of the magnesia-base waste liquor at the Weyerhaeuser Co. where a six-body quintuple effect evaporator was reported to operate satisfactorily. There, waste liquor at 12 to 14% solids, is said to be evaporated to 50 to 55% solids with 4.8 lb. of water evaporated per pound of steam (*1*).

The evaporation of unneutralized sulphite liquor causes the volatilization of considerable sulphur dioxide. Table I shows that evaporation reduces the sulphur:soda ratio from 2.0 to about 1.6 due to the partial pressure of sulphur dioxide in the liquor. This means the disengagement of up to 50 lb. of sulphur per ton pulp, the exact amount depending on many operating conditions.

Most of the sulphur dioxide so evolved can be absorbed by means of a scrubber using make-up soda ash and chemicals recovered in the Sulfox process as will be described. In the

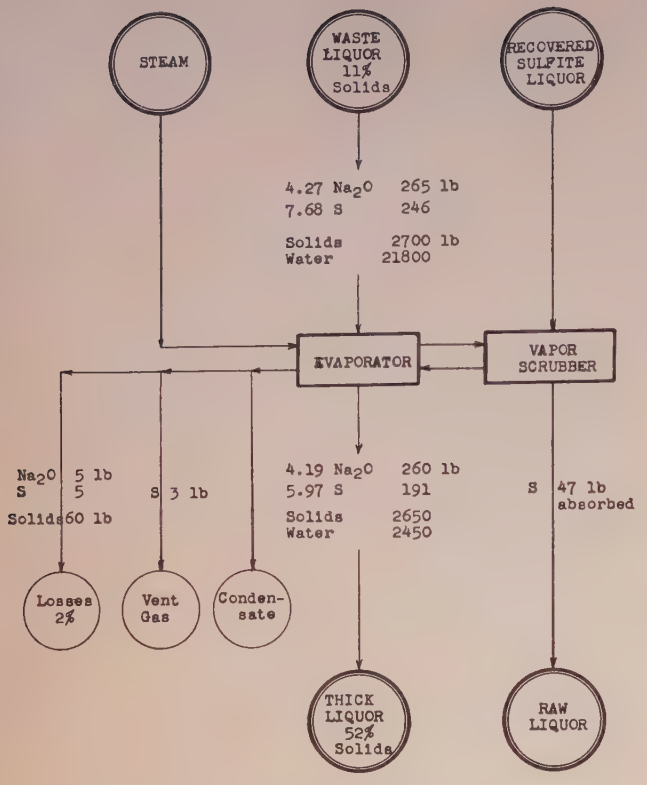

Fig. 3. Soda-base sulphite waste liquor evaporation material balance

Basis 2000 lb. pulp, 90% oven dry

present example, Fig. 3, the volatile sulphur is 50 lb. and a 95% recovery by scrubbing evaporator vapor is considered. A 2% handling loss of all chemicals is allowed.

The evaporation of sulphite waste liquor without neutralization is feasible, and evaporators have been so operated in the magnesia process (*2*). Neutralization before evaporation to a pH of 7.5 to 8.0 is also feasible using recovered sodium carbonate.

For the purpose of these calculations, however, this sulphur dioxide will be deducted in considering the composition of the evaporated waste liquor. Accordingly, allowing for losses, the sulphite liquor, evaporated to 52% solids will contain 191 lb. of sulphur and 260 lb. of sodium oxide in 2650 lb. solids.

Before evaporation the soda and sulphur dioxide were present in almost the exact proportions for acid sulphite. After evaporation the proportions are those of a mixture of acid sulphites and neutral sulphite. There is a corresponding increase in pH, the evaporated liquor having a pH of 4 (*7*).

The probable composition of evaporated waste liquor is shown in Table III. This is a ratio of active $S/Na_2O = 1.53$.

Table III. Evaporated Waste Liquor

Compound	*Pound moles* Na_2O	*Pound moles* S
Na_2SO_4	0.84	0.84
Na_2SO_3	0.31	0.31
$NaHSO_3$	0.35	0.71
Na_2SO_3R	1.26	1.26
$NaHSO_3R$	1.43	2.85
Total	4.19	5.97

COMBUSTION

Soda-base sulphite waste liquor burns readily in modern combustion units such as those widely used in sulphate mills. Its fuel value is somewhat higher than that of sulphate black liquor, and the green ash made handles similarly, though there is less of it. The actual values for soda-base sulphite waste liquor will depend on how much, if any, soda is added for neutralization prior to evaporation.

Soda-base sulphite waste liquor solids, not neutralized, has a gross heat value near 8000 B.t.u. per lb. The liquor can be burned at 50 to 55% solids directly or, for better furnace efficiency, further concentrated in cascade-type evaporators, or even dried in spray driers. The liquor solids per ton pulp is about the same as for sulphate pulp but the soda content of the solids from unneutralized liquor is only about 40% as high. The smelt from soda-base sulphite liquor is also richer in sulphide.

The stack gas from the combustion of soda-base sulphite waste liquor contains several times the concentration of sulphur dioxide found in sulphate mill stacks and this gas would be scrubbed using recovered soda ash. The combustion furnace generates considerable soda fume and this would be collected in scrubbers or by means of electrical precipitators like those in use in sulphate mills.

The material balance typical for a combustion unit using soda-base sulphite waste liquor is shown in Fig. 4.

Furnace Reactions

The combustion of the waste liquor, resulting in a smelt, converts the chemicals into sodium sulphide, carbonate, and some sulphate. Considerable sulphur dioxide is carried off in the combustion gas.

In the furnace the liquor first drys, then chars. At this stage sodium sulphate remains unchanged. Organic and inorganic sulphites decompose and organic matter becomes mostly carbon. The reactions of the sulphur and sodium compounds are approximated by the following:

$$2NaHSO_3 \rightarrow Na_2SO_3 + SO_2$$
$$2Na_2SO_3 \rightarrow Na_2SO_4 + Na_2CO_3 + SO_2$$
$$2NaHSO_3R \rightarrow Na_2SO_3R + SO_2$$
$$2Na_2SO_3R \rightarrow Na_2SO_4 + Na_2CO_3 + SO_2$$

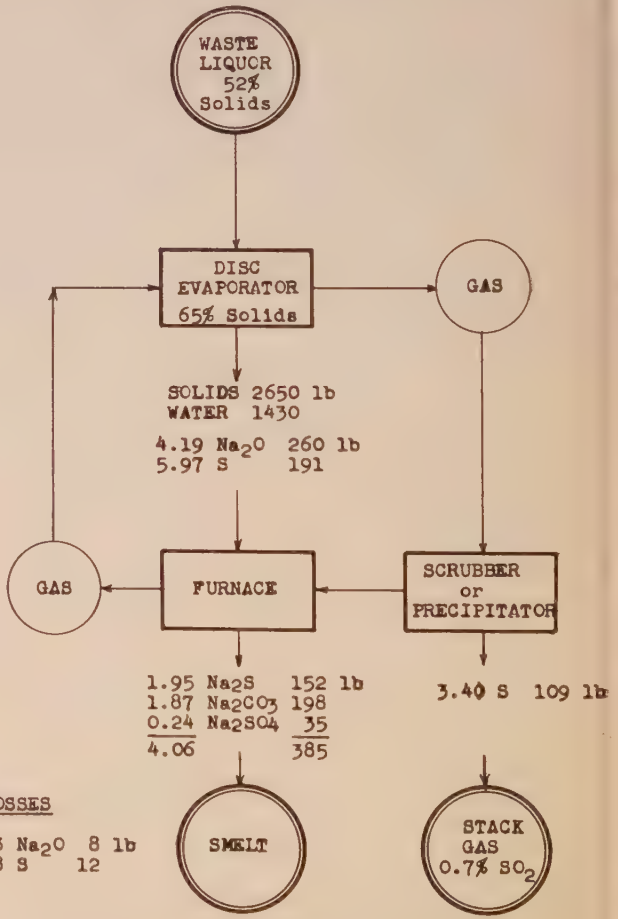

Fig. 4. Soda-base sulphite waste liquor combustion material balance

Basis 2000 lb. pulp, 90% oven dry

Combustion and reduction follow. Reduction is never complete and is accompanied by the formation of some sodium carbonate, approximately:

$$Na_2SO_4 \rightarrow 0.8Na_2S + 0.1Na_2SO_4 + 0.1Na_2CO_3 + 0.1SO_2$$

The loss of soda due to volatilization may amount to perhaps 1%, assuming an electrical precipitator would be used. At this point, too, miscellaneous chemical losses in the process, about 2%, are also provided for.

The result of these reactions, allowing for losses, thus yields, in pound moles per ton pulp:

Table IV. Char Products

Compounds	*Moles products* Na_2SO_4	Na_2CO_3	SO_2
$0.84Na_2SO_4$	0.82	...	...
$0.31Na_2SO_3$	0.15	0.15	0.15
$0.71NaHSO_3$	0.17	0.17	0.52
$1.26Na_2SO_3R$	0.62	0.62	0.62
$2.85NaHSO_3R$	0.70	0.70	2.10
Total	2.46	1.64	3.39

The reduction reactions then result, allowing for losses, in the following smelt composition:

Table V. Smelt Composition

	Moles	*Mole, %*	*Pounds*	*Weight, %*
Sodium sulphide	1.95	48	152	40
Sodium carbonate	1.87	46	198	51
Sodium sulphate	0.24	6	35	9
Total	4.06	100	385	100

The combustion gas then contains 3.4 moles SO_2, equivalent to 109 lb. of sulphur.

SULPHIDE OXIDATION

The smelt from the combustion of soda-base sulphite waste liquor is dissolved using a somewhat different procedure than the current practice in sulphate pulp mills. The resulting liquor is then ready for oxidation.

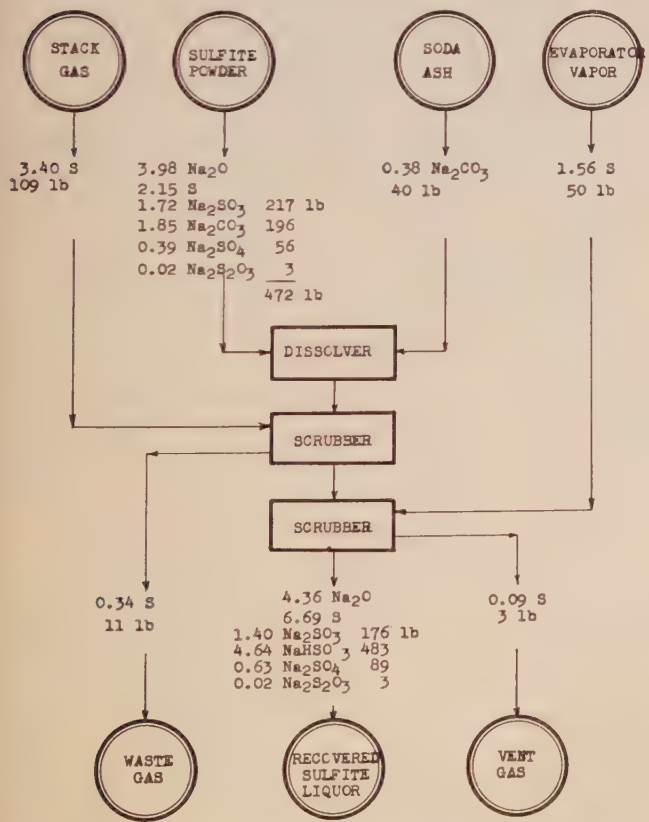

Fig. 5. Sulfox process sulphur dioxide recovery material balance
Basis 2000 lb. pulp, 90% oven dry

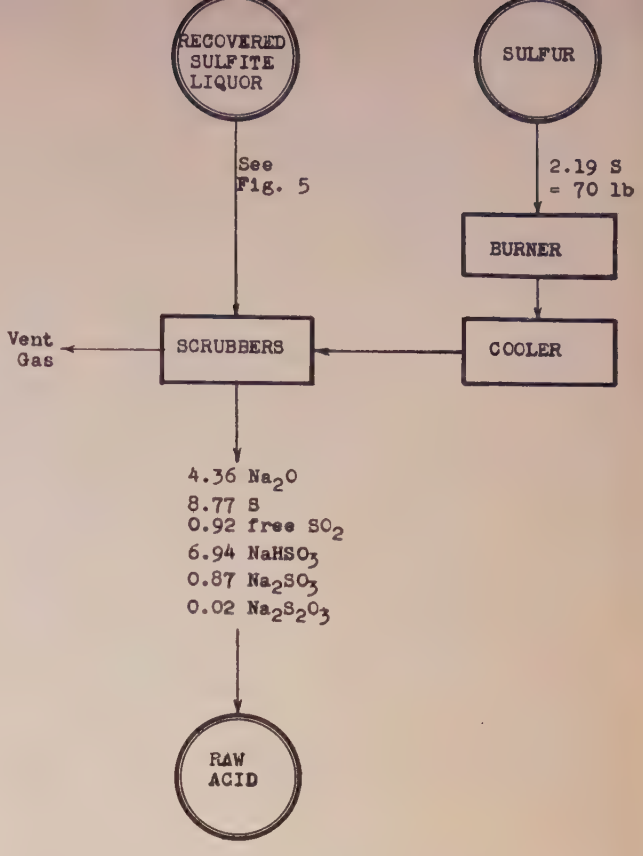

Fig. 6. Sulfox process raw cooking acid material balance
Basis 2000 lb. pulp, 90% oven dry

The sodium sulphide is converted directly into sodium sulphite by oxidation with air. No catalyst is needed, and the conversion yield is about 90%. The balance is mostly sodium sulphate with a very small amount going to sodium thiosulphate. The sodium carbonate in the green ash is inert and does not impair the oxidation reaction.

The oxidation consumes considerable oxygen and so a good deal of air must be supplied. To avoid undesirable side products the volume and temperature of the air must be controlled to a reasonable extent. The preferred temperature is in the range of 275 to 300°F.

To make all this air available to the sodium sulphide at atmospheric pressure a special way of contacting was devised.

The product is a dry powder—a mixture of sodium carbonate and sodium sulphite. Per ton of pulp, the smelt chemicals listed in Table V, are thus converted in the composition shown in Table VI. A 2% handling loss is allowed.

Table VI. Sulphite Powder Composition

	Moles	*Mole, %*	*Pounds*	*Weight, %*
Sodium sulphite	1.72	43	217	46
Sodium carbonate	1.85	46	196	42
Sodium sulphate	0.39	10	56	11
Sodium sulphide	0.00	0	0	0
Sodium thiosulphate	0.02	1	3	1
Total	3.98	100	472	100

SULPHUR DIOXIDE RECOVERY

Sulphur dioxide is available for recovery at two points of the process. The first is at the evaporators assuming there is no neutralization. As has been noted earlier, this amounts to about 50 lb. sulphur (1.56 moles) per ton pulp. Another 109 lb. of sulphur (3.40 moles) is to be found in the waste liquor furnace combustion gas as SO_2.

The sulphur recovered with the soda amounts to 69 lb. (2.15 moles) of the 281 lb. (8.77 moles) used in the process. This is a recovery of 25%.

Recovering 90% of the sulphur dioxide in the waste liquor furnace combustion gas would add another 99 lb. (3.09 moles) of sulphur and so increase the sulphur recovery another 35%.

Recovering 94% of the sulphur dioxide in the evaporator vapor adds another 47 lb. (1.47 moles) sulphur, a recovery of another 17%.

All of these sources together would total a recovery of 77% of the sulphur. The sulphur make-up is then 66 lb. per ton pulp. Figures 5 and 6 are flowsheets for these steps.

STACK GAS SCRUBBER

The stack gas from a furnace burning soda-base sulphite waste liquor is much richer in sulphur dioxide than the gas from burning sulphate waste liquor.

The sulphite gas contains about 0.7% SO_2, hot, wet gas basis. A ton of pulp results in about 460 lb. moles of wet stack gas, about 150 c.f.m. at 150°F. per daily ton pulp. A 100-ton mill would require a scrubber about 10 ft. in diameter with only a few feet of filling or of equivalent devices to recover only 90% of the sulphur. A better recovery may be feasible but a very efficient scrubber is to be avoided; the excess air in the stack gas causes too much oxidation to sulphate.

The scrubbing chemicals would be the sulphite powder product plus 40 lb. of new soda ash (0.38 mole) as make-up. The scrubbing liquor can absorb SO_2 up to a molar ratio of S/Na_2O of about 1.3 (*8*). The active Na_2O in the sulphite powder, see Table VI, totals 3.57 moles and the active sulphur, 1.72 moles. With the new soda ash added this is a ratio of S/NaO of only 1.72/3.95 = 0.43. This allows the absorption of (1.3) (3.95) − 1.72 = 3.4 moles SO_2. A 90% recovery would add only 3.1 moles bringing the active S/N_2O ratio to only 1.22, Figure 5 shows the material balance with an allowance for some oxidation to sodium sulphate.

EVAPORATOR VAPOR SCRUBBER

The sulphur dioxide liberated from unneutralized soda-base sulphite waste liquor during evaporation is much richer than stack gas and consequently can be absorbed in liquors of a much higher active S/Na_2O ratio than in stack gas. Accordingly it is feasible to use the recovered sulphite liquor after enrichment with the SO_2 in the stack gas.

Recovering 95% of this SO_2 would make a sulphite liquor with an active S/Na_2O ratio of 6.04/3.72 or 1.62. This approximates the composition $Na_2SO_3 + 3NaHSO_3$.

This liquor is then fortified with sulphur burner gas to make raw cooking liquor in the customary way.

CHEMICALS MAKE-UP

The make-up of soda has already been noted in connection with the addition of new soda ash to the scrubbing liquor. As indicated in Fig. 5, 40 lb. of soda ash suffice as make-up. This is a recovery of about 91% of the soda used.

The recovery of sulphur is not so complete and, as has been shown, is only 76%. This may be improved, much depending on local operating conditions. As shown in Fig. 6 a make-up of 70 lb. of sulphur corresponds to the 24% loss with an allowance also for losses during sulphur burning.

The resulting raw liquor contains 1.5% free SO_2, 1.2% combined SO_2, 2.7 total SO_2. This is based on the use of 19,000 lb. of cooking liquor per ton pulp—about 2200 gal.

The Sulfox process also provides simple and effective means for recovering the waste liquors of the neutral sulphite and neutral sulphite semichemical pulp processes.

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Received Aug. 8, 1951. Presented at the 36th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 18–21, 1951.

RECENT BOOKS

Nomography and Empirical Equations. By Lee H. Johnson, Tulane University. John Wiley & Sons, New York, 1952. Cloth, 6 × 9, 150 pages. $3.75.

The purpose of this book is to explain two useful methods for handling data from experiments, which gives quick graphical answers where numerical data are substituted into formulas, and empirical equations, which are the mathematical expressions of data plotted in the form of curves. Ninety-six illustrations increase the value of the book. There is a need for more books of this type since the contents of each volume is limited to the author's experience.

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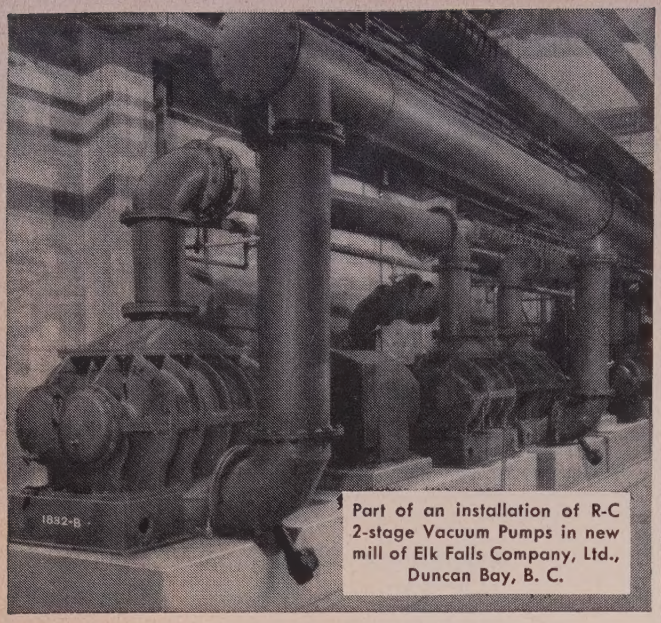

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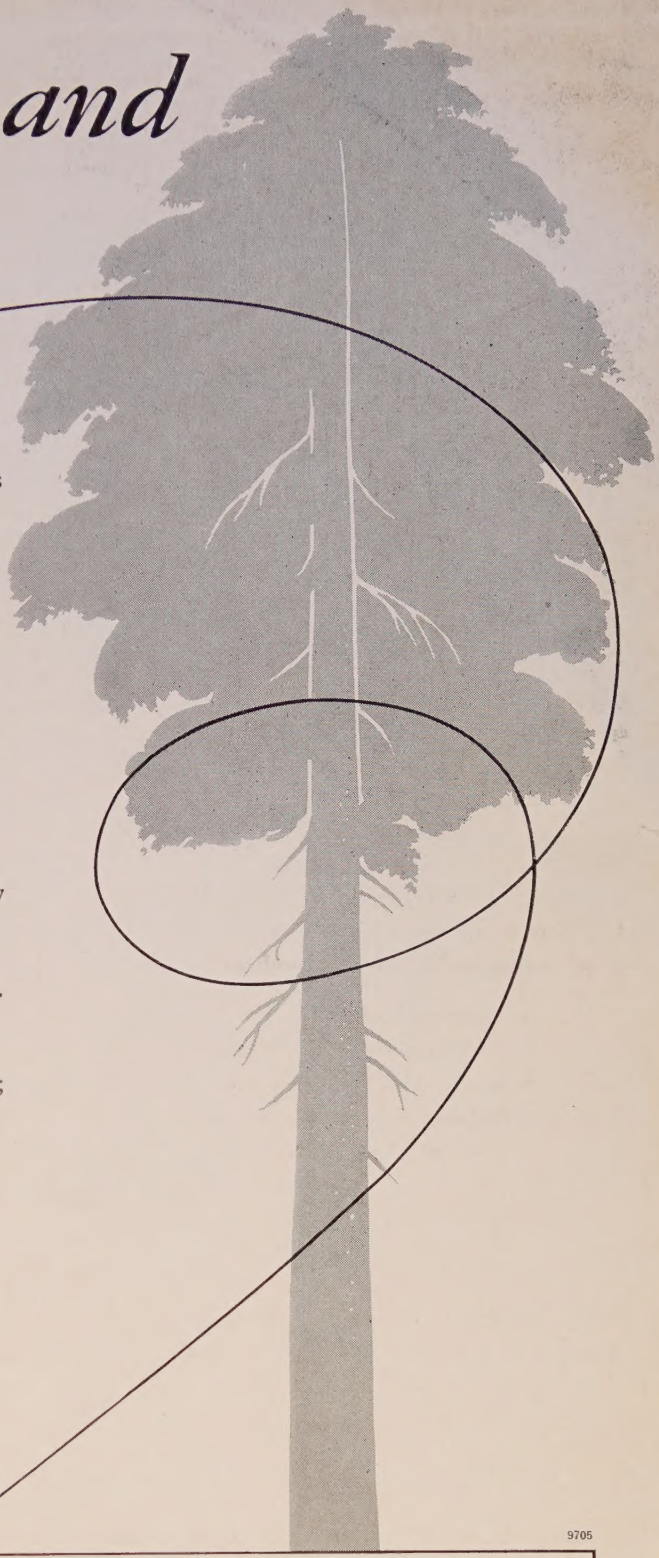

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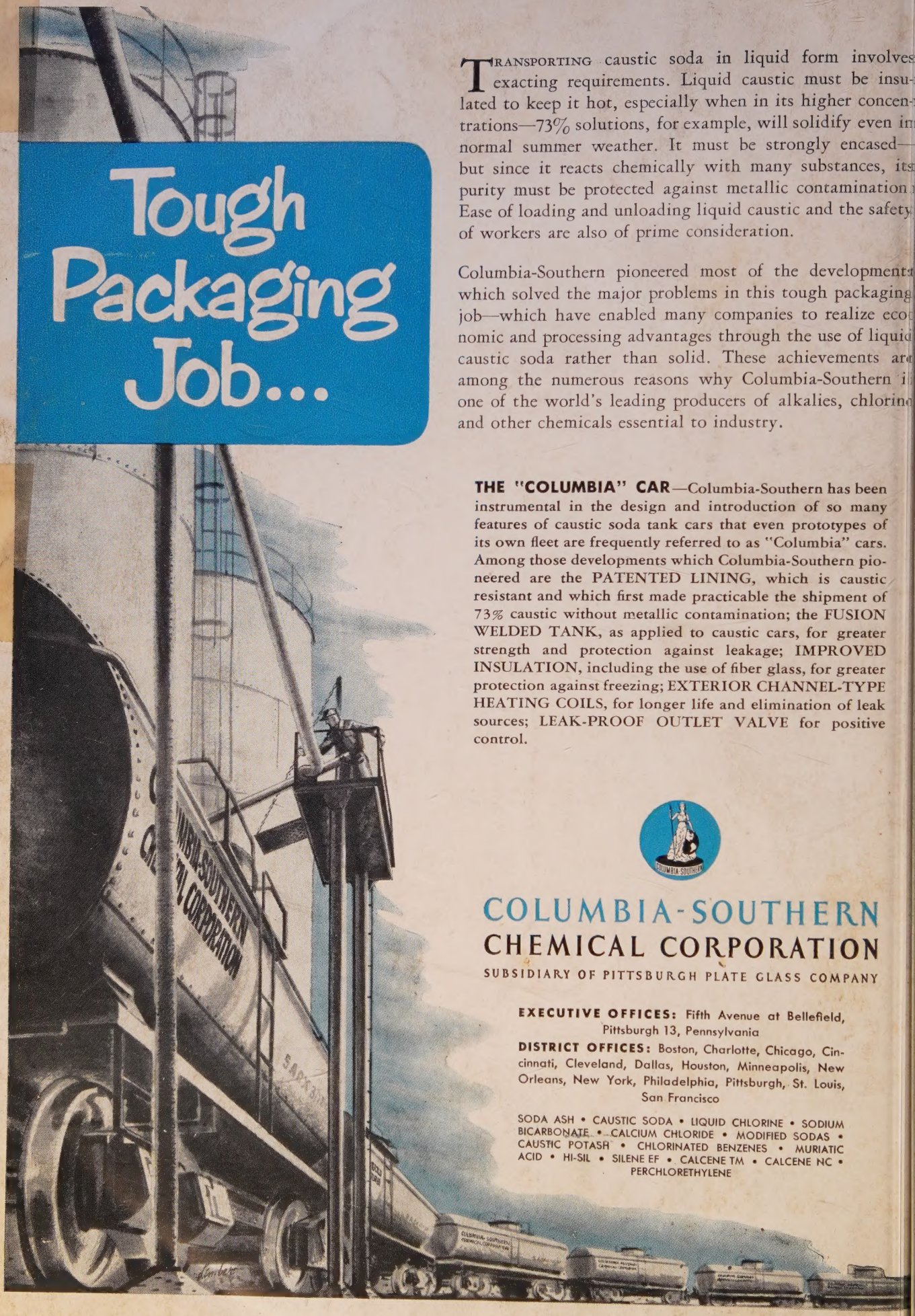

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